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(54) **CHIMERIC PROMOTERS AND THEIR USES THEREOF IN PLANTS**

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CPC ..... **C12N 15/8234** (2013.01)

(58) **Field of Classification Search**  
None  
See application file for complete search history.

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(57) **ABSTRACT**

The present invention provides novel promoters for use in plants. Specifically, the present invention provides novel enhanced plant promoters. The present invention also provides DNA constructs; transgenic cells, plants, and seeds containing these novel promoters; and methods for preparing and using the same.

**12 Claims, 3 Drawing Sheets**

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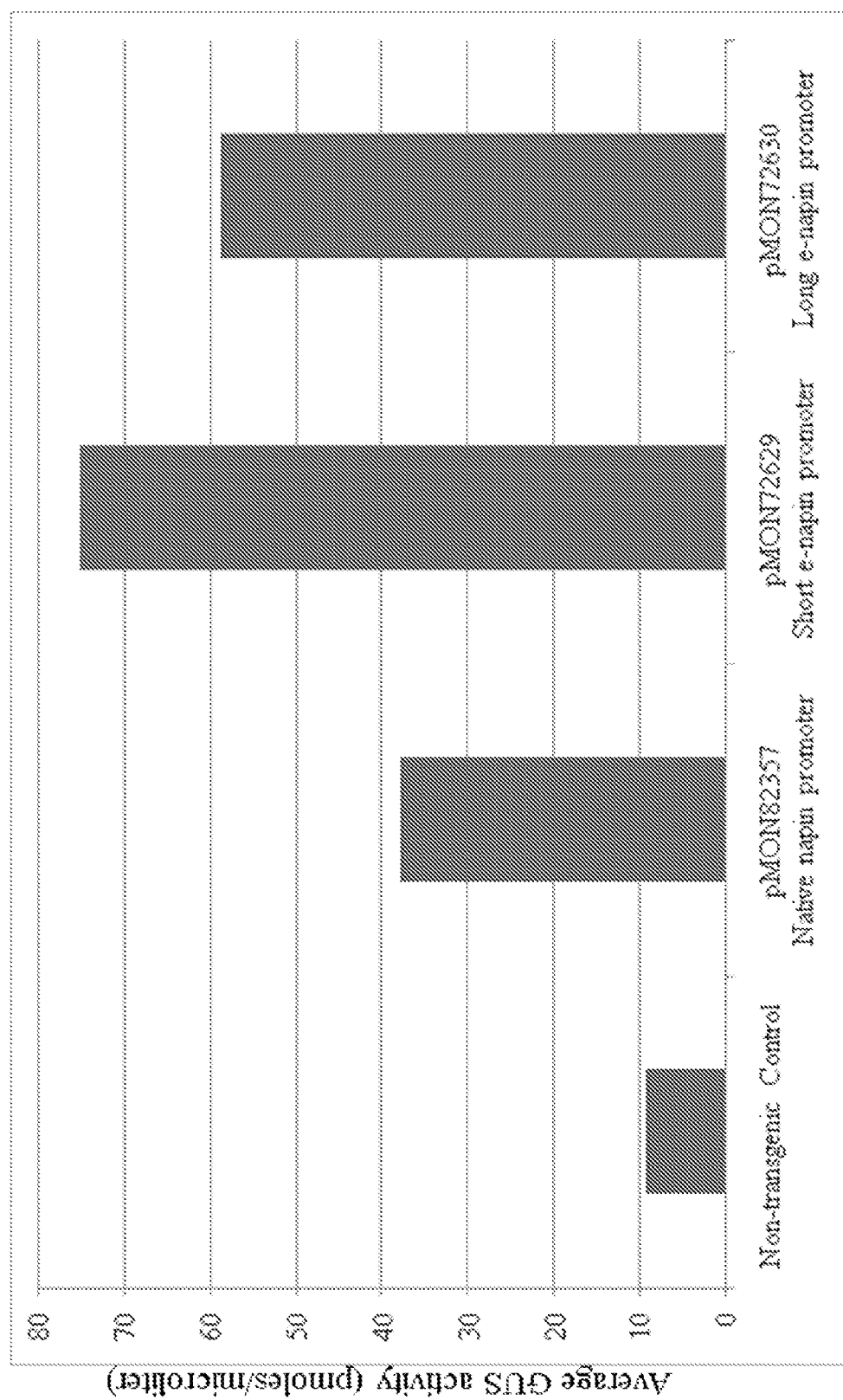


FIG. 1

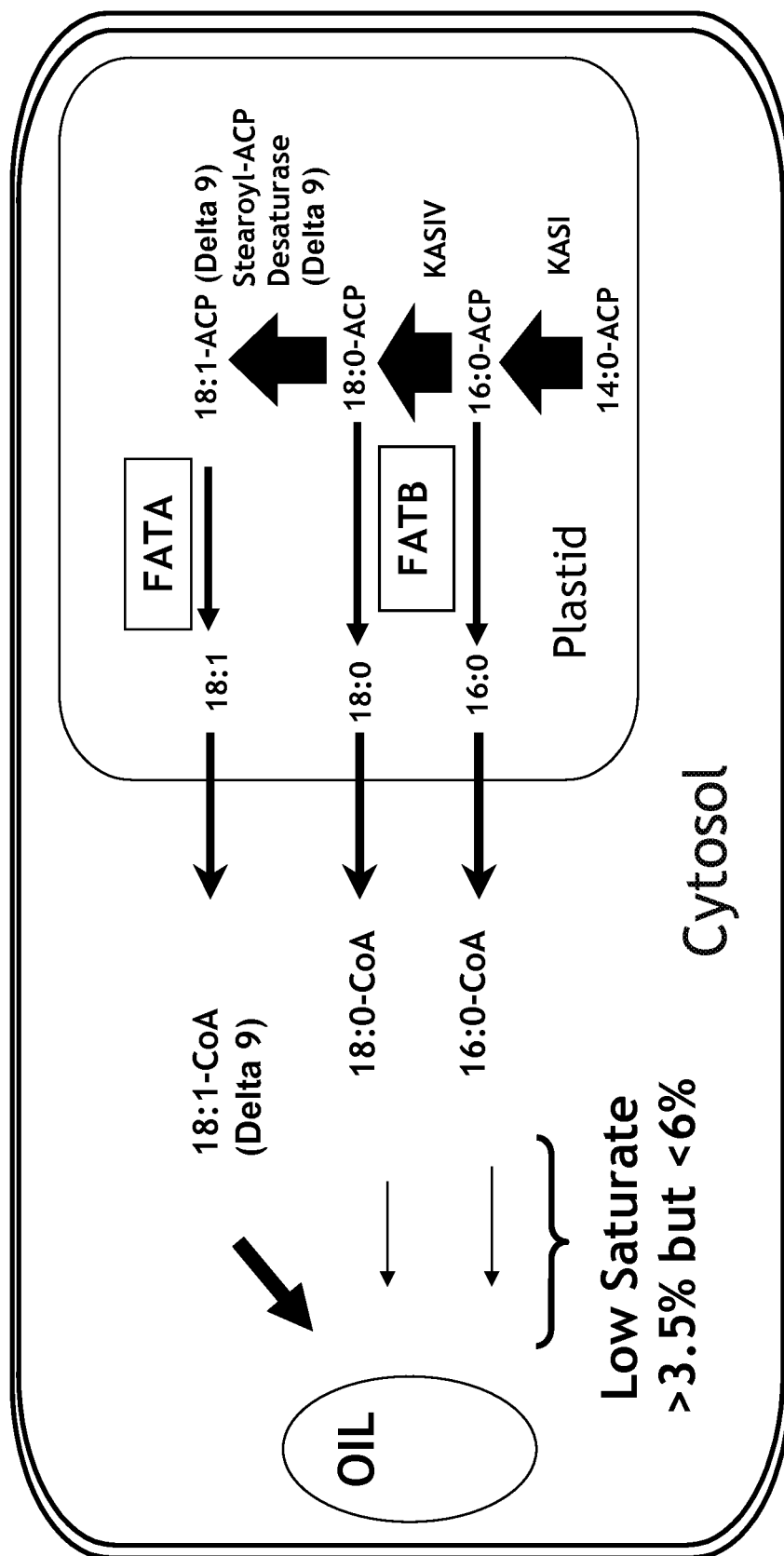


FIG. 2

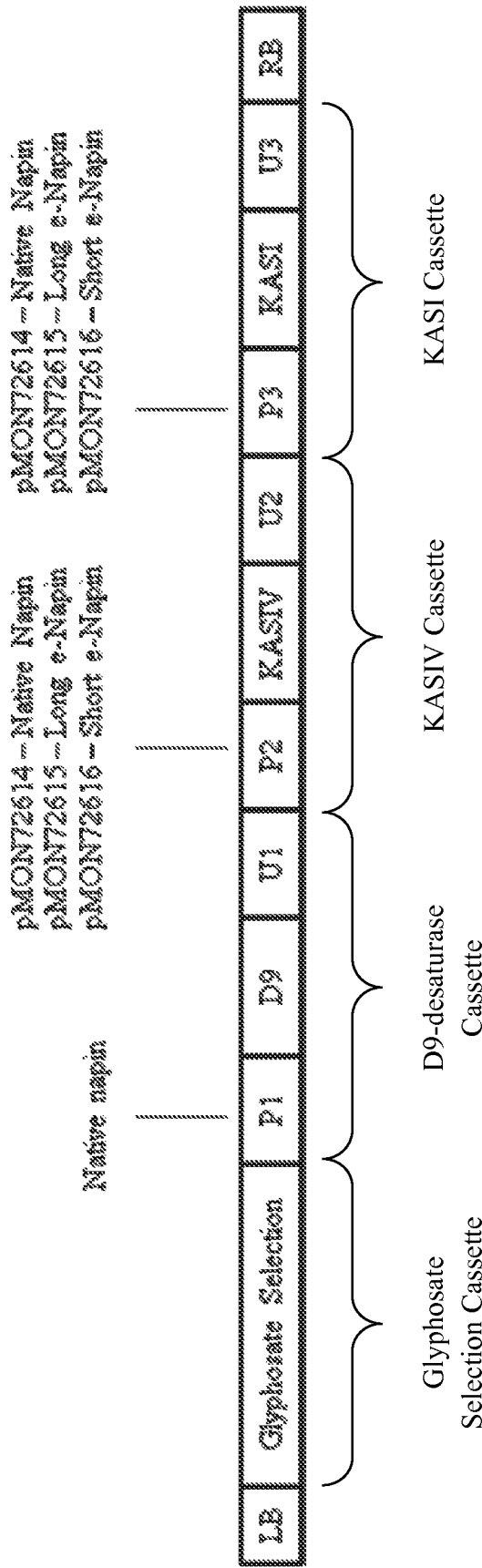


FIG. 3

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## CHIMERIC PROMOTERS AND THEIR USES THEREOF IN PLANTS

This application claims the benefit of U.S. Provisional Patent Application No. 61/037,126 filed Mar. 17, 2008, herein incorporated by reference in its entirety.

### INCORPORATION OF SEQUENCE LISTING

The sequence listing that is contained in the file named “MONS223WO\_seq\_ST25.txt”, which is 47 kilobytes (as measured in Microsoft Windows®) and was created on Mar. 11, 2009, is filed herewith by electronic submission and is incorporated by reference herein.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The invention relates to the field of plant molecular biology and plant genetic engineering and DNA molecules useful for modulating gene expression in plants.

#### 2. Description of Related Art

Promoters are genetic elements that regulate gene activity by modulating the transcription of an operably linked transcribable polynucleotide molecule. Promoters may be defined as constitutive, i.e. generally always active, or by their temporal, spatial, developmental, tissue, environmental, physiological, pathological, cell cycle, and/or chemically responsive expression pattern, and any combination thereof, as well as by quantitative or qualitative indications.

### SUMMARY OF THE INVENTION

The present invention provides novel chimeric promoters and enhancers for use in plants. The present invention also provides DNA constructs comprising the chimeric promoters. The present invention also provides transgenic plant cells, plants, and seeds comprising the chimeric promoters operably linked to a transcribable polynucleotide molecule. The present invention also provides methods of making and using the chimeric promoters, the DNA constructs comprising the chimeric promoters, and the transgenic plant cells, plants, and seeds comprising the chimeric promoters operably linked to a transcribable polynucleotide molecule.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the average GUS activity in picomoles/microliter measured in seed from canola plants transformed with a construct in which the native napin promoter, short e-napin promoter, or long e-napin promoter was operably linked to the *E. coli* beta-glucuronidase gene. Data from non-transgenic canola plants is also provided as a control.

FIG. 2 illustrates schematically the fatty acid biosynthesis pathway in plants.

FIG. 3 illustrates schematically the constructs used for analyzing the chimeric promoters driving expression of fatty acid biosynthesis enzymes. These constructs contain four coding sequences, each with its own operably linked regulatory elements. The left border sequence is indicated as “LB”; a selection cassette for glyphosate tolerance is indicated as “Glyphosate Selection Cassette”; a cassette for expression of the D9-desaturase enzyme containing the native napin promoter (indicated as “P1”), operably linked to the D9-desaturase coding sequence (indicated as “D9”), operably linked to the native napin 3' UTR (indicated as “U1”) is indicated as “D9-desaturase Cassette”; a KASIV cassette for the expres-

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sion of the KASIV enzyme containing either the native napin promoter (pMON72614), the long e-napin promoter (pMON72615), or the short e-napin promoter (pMON72616) each indicated as “P2”, operably linked to the KASIV coding sequence (indicated as “KASIV”), operably linked to the native napin 3' UTR (indicated as “U2”) is indicated as “KASIV Cassette”; a KASI cassette for the expression of the KASI enzyme containing either the native napin promoter (pMON72614), the long e-napin promoter (pMON72615), or the short e-napin promoter (pMON72616) indicated as “P3”, operably linked to the KASI coding sequence (indicated as KASI), operably linked to the native napin 3' UTR (indicated as “U3”) is indicated as “KASI Cassette”; and the right border sequence is indicated as “RB”.

### BRIEF DESCRIPTION OF THE SEQUENCE LISTING

SEQ ID NO: 1 is the DNA sequence of the short e-napin chimeric promoter.

SEQ ID NO: 2 is the DNA sequence of the long e-napin chimeric promoter.

SEQ ID NO: 3 is the DNA sequence of the short e-napin chimeric promoter plus napin leader.

SEQ ID NO: 4 is the DNA sequence of the long e-napin chimeric promoter plus napin leader.

SEQ ID NO: 5 is the DNA sequence of the napin leader.

SEQ ID NO: 6 is the DNA sequence of a native napin promoter plus napin leader from *Brassica rapa* (cv. ‘Ebony’).

SEQ ID NO: 7 is the DNA sequence of a native napin promoter from *Brassica rapa* (cv. ‘Ebony’).

SEQ ID NO: 8 is the DNA sequence of a native napin promoter from *Brassica juncea*.

SEQ ID NO: 9 is the DNA sequence of a native napin promoter from *Brassica napus* (rape).

SEQ ID NO: 10 is the DNA sequence of a native napin promoter from *Brassica napus* (rape).

SEQ ID NO: 11 is the DNA sequence of a native napin promoter from *Brassica napus* (rape).

SEQ ID NO: 12 is the DNA sequence of a native napin promoter from *Brassica napus* (rape).

SEQ ID NO: 13 is the DNA sequence of a native napin promoter from *Brassica oleracea*.

SEQ ID NO: 14 is the DNA sequence of a native napin promoter from *Brassica napus* (rape).

SEQ ID NO: 15 is the DNA sequence of a native napin promoter from *Brassica rapa*.

SEQ ID NO: 16 is the DNA sequence of a native napin promoter from *Brassica rapa*.

SEQ ID NO: 17 is the DNA sequence of a native napin promoter from *Arabidopsis thaliana*.

SEQ ID NO: 18 is the DNA sequence of a native actin 7 promoter from *Arabidopsis thaliana*.

SEQ ID NO: 19 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 20 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 21 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 22 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 23 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 24 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 25 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 26 is the DNA sequence of a highly conserved domain enhancer element.

SEQ ID NO: 27 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 28 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 29 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 30 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 31 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 32 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 33 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 34 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 35 is the DNA sequence of a conserved domain enhancer element.

SEQ ID NO: 36 is the DNA sequence of the short e-actin chimeric promoter.

SEQ ID NO: 37 is the DNA sequence of the long e-actin chimeric promoter.

#### DETAILED DESCRIPTION OF THE INVENTION

The following definitions and methods are provided to better define the present invention and to guide those of ordinary skill in the art in the practice of the present invention. Unless otherwise noted, terms are to be understood according to conventional usage by those of ordinary skill in the relevant art.

##### DNA Molecules

As used herein, the term "DNA" or "DNA molecule" refers to a double-stranded DNA molecule of genomic or synthetic origin, i.e., a polymer of deoxyribonucleotide bases or a polynucleotide molecule, read from the 5' (upstream) end to the 3' (downstream) end. As used herein, the term "DNA sequence" refers to the nucleotide sequence of a DNA molecule. The nomenclature used herein is that required by Title 37 of the United States Code of Federal Regulations §1.822 and set forth in the tables in WIPO Standard ST.25 (1998), Appendix 2, Tables 1 and 3.

As used herein, the term "isolated DNA molecule" refers to a DNA molecule at least partially separated from other molecules normally associated with it in its native or natural state. In one embodiment, the term "isolated" refers to a DNA molecule that is at least partially separated from the nucleic acids which normally flank the DNA molecule in its native or natural state. Thus, DNA molecules fused to regulatory or coding sequences with which they are not normally associated, for example as the result of recombinant techniques, are considered isolated herein. Such molecules are considered isolated even when integrated into the chromosome of a host cell or present in a nucleic acid solution with other DNA molecules.

Any number of methods well known to those skilled in the art can be used to isolate and manipulate a DNA molecule, or fragment thereof, disclosed in the present invention. For example, PCR (polymerase chain reaction) technology can be used to amplify a particular starting DNA molecule and/or to produce variants of the original molecule. DNA molecules, or fragment thereof, can also be obtained by other techniques such as by directly synthesizing the fragment by chemical means, as is commonly practiced by using an automated oligonucleotide synthesizer.

As used herein, the term "sequence identity" refers to the extent to which two optimally aligned polynucleotide sequences are identical. An optimal sequence alignment is created by manually aligning two sequences, e.g. a reference sequence and another sequence, to maximize the number of nucleotide matches in the sequence alignment with appropriate internal nucleotide insertions, deletions, or gaps. Other methods useful for aligning sequences are well known to those skilled in the art, such as the computerized implementations of the alignment algorithms of Smith and Waterman (Smith and Waterman, *Advances in Applied Mathematics*, 2:482-489, 1981, Smith et al., *Nucleic Acids Research*, 11:2205-2220 (1983)) and Needleman and Wunsch (Needleman and Wunsch, *Journal of Molecular Biology*, 48:443-453 (1970)). Computer implementations of these are available from EMBOSS (Rice, P. Longden, I. and Bleasby, A., "EMBOSS: The European Molecular Biology Open Software Suite" *Trends in Genetics* 16:276-277 (2000)). As used herein, the term "reference sequence" refers to a sequence provided as SEQ ID NO: 1-4 and 19-35.

As used herein, the term "percent sequence identity" or "percent identity" or "% identity" is the identity fraction times 100. The "identity fraction" for a sequence optimally aligned with a reference sequence is the number of nucleotide matches in the optimal alignment, divided by the total number of nucleotides in the reference sequence, e.g. the total number of nucleotides in the full length of the entire reference sequence. Thus, one embodiment of the invention is a DNA molecule comprising a sequence that when optimally aligned to a reference sequence, provided herein as SEQ ID NO: 1-4 and 19-35, has at least 90 percent identity or higher, about 95 percent identity or higher, or at least 96 percent identity, 97 percent identity, 98 percent identity, or 99 percent identity to the reference sequence and has gene regulatory activity.

##### Promoters

As used herein, the term "promoter" refers generally to a DNA molecule that is involved in recognition and binding of RNA polymerase II and other proteins (trans-acting transcription factors) to initiate transcription. A promoter may be initially isolated from the 5' untranslated region (5' UTR) of a genomic copy of a gene. Alternately, promoters may be synthetically produced or manipulated DNA molecules. Promoters may also be chimeric, that is a promoter produced through the fusion of two or more DNA molecules. Promoters useful in practicing the present invention include SEQ ID NO: 1-4, 6-18, 36-37 or fragments or variants thereof.

As used herein, the term "chimeric" refers to a single DNA molecule produced by fusing a first DNA molecule to a second DNA molecule, where neither first nor second DNA molecule would normally be found in that configuration, i.e. fused to the other. The chimeric DNA molecule is thus a new DNA molecule not otherwise normally found in nature. As used herein, the term "chimeric promoter" refers to a promoter produced through such manipulation of DNA molecules. A chimeric promoter may combine two or more DNA fragments; an example would be the fusion of a promoter to an enhancer element. Thus, the design, construction, and use of chimeric promoters according to the methods disclosed herein for modulating the expression of operably linked transcribable polynucleotide molecules are encompassed by the present invention. Chimeric promoters useful in practicing the present invention include SEQ ID NO: 1-4 and 36-37.

Promoters may be characterized by their expression pattern, i.e. as constitutive and/or by their temporal, spatial, developmental, tissue, environmental, physiological, pathological, cell cycle, and/or chemically responsive expression pattern, and any combination thereof, as well as by quantita-

tive or qualitative indications. A promoter is useful as a regulatory element for modulating the expression of an operably linked transcribable polynucleotide molecule.

As used herein, a “gene expression pattern” is any pattern of transcription of an operably linked DNA molecule into a transcribed RNA molecule. Expression may be characterized by its temporal, spatial, developmental, tissue, environmental, physiological, pathological, cell cycle, and/or chemically responsive qualities as well as by quantitative or qualitative indications. The transcribed RNA molecule may be translated to produce a protein molecule or may provide an antisense or other regulatory RNA molecule, such as a dsRNA, a tRNA, an rRNA, a miRNA, and the like.

As used herein, the term “protein expression” is any pattern of translation of a transcribed RNA molecule into a protein molecule. Protein expression may be characterized by its temporal, spatial, developmental, or morphological qualities as well as by quantitative or qualitative indications.

As used herein, the term “gene regulatory activity” refers to the ability to affect the expression pattern of an operably linked transcribable polynucleotide molecule by affecting the transcription and/or translation of that operably linked transcribable polynucleotide molecule. Gene regulatory activity may be positive and/or negative and the effect may be characterized by its temporal, spatial, developmental, tissue, environmental, physiological, pathological, cell cycle, and/or chemically responsive qualities as well as by quantitative or qualitative indications.

As used herein, the term “regulatory element” refers to a DNA molecule having gene regulatory activity, i.e. one that has the ability to affect the transcription and/or translation of an operably linked transcribable polynucleotide molecule. Regulatory elements such as promoters, leaders, introns, and transcription termination regions are DNA molecules that have gene regulatory activity and play an integral part in the overall expression of genes in living cells. Isolated regulatory elements, such as promoters, that function in plants are therefore useful for modifying plant phenotypes through the methods of genetic engineering.

In one embodiment, fragments are provided of a promoter sequence disclosed herein. Promoter fragments may exhibit promoter activity, and may be useful alone or in combination with other promoters and promoter fragments, such as in constructing chimeric promoters. In specific embodiments, fragments of a promoter are provided comprising at least about 50, 95, 150, 250, 500, or about 750 contiguous nucleotides of a polynucleotide molecule having promoter activity disclosed herein.

As used herein, the term “variant” refers to a second DNA molecule that is in composition similar, but not identical to, a first DNA molecule and yet the second DNA molecule still maintains the general functionality, i.e. same or similar expression pattern, of the first DNA molecule. A variant may be a shorter or truncated version of the first DNA molecule and/or an altered version of the sequence of the first DNA molecule, such as one with different restriction enzyme sites and/or internal deletions, substitutions, and/or insertions. In the present invention, a polynucleotide sequence provided as SEQ ID NO: 1-4 may be used to create variants that are in composition similar, but not identical to, the polynucleotide sequence of the original promoter, while still maintaining the general functionality, i.e. same or similar expression pattern, of the original promoter. Production of such variants of the present invention is well within the ordinary skill of the art in light of the disclosure and is encompassed within the scope of the present invention.

A promoter or promoter fragment may also be analyzed for the presence of known promoter elements, i.e. DNA sequence characteristics, such as a TATA-box and other known transcription factor binding site motifs. Identification of such known promoter elements may be used by one of skill in the art to design variants of the promoter having a similar expression pattern to the original promoter.

As used herein, the term “enhancer” or “enhancer element” refers to a cis-acting transcriptional regulatory element, a.k.a. cis-element, which confers an aspect of the overall expression pattern, but is usually insufficient alone to drive transcription, of an operably linked polynucleotide sequence. Unlike promoters, enhancer elements do not usually include a transcription start site (TSS) or TATA box. A promoter may naturally comprise one or more enhancer elements that affect the transcription of an operably linked polynucleotide sequence. An isolated enhancer element may also be fused to a promoter to produce a chimeric promoter. Enhancer elements can be obtained by chemical synthesis or by isolation from regulatory elements that include such elements, and they can be synthesized with additional flanking nucleotides that contain useful restriction enzyme sites to facilitate subsequent manipulation. Thus, the design, construction, and use of enhancer elements according to the methods disclosed herein for modulating the expression of operably linked transcribable polynucleotide molecules are encompassed by the present invention.

#### Constructs

As used herein, the term “construct” means any recombinant polynucleotide molecule such as a plasmid, cosmid, virus, autonomously replicating polynucleotide molecule, phage, or linear or circular single-stranded or double-stranded DNA or RNA polynucleotide molecule, derived from any source, capable of genomic integration or autonomous replication, comprising a polynucleotide molecule where one or more polynucleotide molecule has been linked in a functionally operative manner, i.e., operably linked. As used herein, the term “vector” means any recombinant polynucleotide construct that may be used for the purpose of transformation, i.e., the introduction of heterologous DNA into a host cell.

As used herein, the term “operably linked” refers to a first molecule joined to a second molecule, wherein the molecules are so arranged that the first molecule affects the function of the second molecule. The two molecules may or may not be part of a single contiguous molecule and may or may not be adjacent. For example, a promoter is operably linked to a transcribable polynucleotide molecule if the promoter modulates transcription of the transcribable polynucleotide molecule of interest in a cell.

The constructs of the present invention are generally double Ti plasmid border DNA constructs that have the right border (RB) and left border (LB) regions of the Ti plasmid isolated from *Agrobacterium tumefaciens* comprising a T-DNA, that along with transfer molecules provided by the *Agrobacterium tumefaciens* cells, permit the integration of the T-DNA into the genome of a plant cell (see, for example, U.S. Pat. No. 6,603,061). The constructs may also contain the plasmid backbone DNA segments that provide replication function and antibiotic selection in bacterial cells, for example, an *Escherichia coli* origin of replication such as ori322, a broad host range origin of replication such as oriV or oriRi, and a coding region for a selectable marker such as Spec/Strp that encodes for Tn7 aminoglycoside adenylyltransferase (aadA) conferring resistance to spectinomycin or streptomycin, or a gentamicin (Gm, Gent) selectable marker gene. For plant transformation, the host bacterial strain is



often *Agrobacterium tumefaciens* ABI, C58, or LBA4404; however, other strains known to those skilled in the art of plant transformation can function in the present invention.

Methods are known in the art for assembling and introducing constructs into a cell in such a manner that the transcribable polynucleotide molecule is transcribed into a functional mRNA molecule that is translated and expressed as a protein product. For the practice of the present invention, conventional compositions and methods for preparing and using constructs and host cells are well known to one skilled in the art, see, for example, *Molecular Cloning: A Laboratory Manual*, 3<sup>rd</sup> edition Volumes 1, 2, and 3, J. F. Sambrook, D. W. Russell, and N. Irwin, Cold Spring Harbor Laboratory Press (2000). Methods for making recombinant vectors particularly suited to plant transformation include, without limitation, those described in U.S. Pat. Nos. 4,971,908; 4,940,835; 4,769,061; and 4,757,011. These types of vectors have also been reviewed in the scientific literature (see, for example, Rodriguez, et al., *Vectors: A Survey of Molecular Cloning Vectors and Their Uses*, Butterworths, Boston, (1988) and Glick, et al., *Methods in Plant Molecular Biology and Biotechnology*, CRC Press, Boca Raton, Fla. (1993)). Typical vectors useful for expression of nucleic acids in higher plants are well known in the art and include vectors derived from the tumor-inducing (Ti) plasmid of *Agrobacterium tumefaciens* (Rogers, et al., *Methods in Enzymology*, 153: 253-277 (1987)). Other recombinant vectors useful for plant transformation, including the pCaMVCN transfer control vector, have also been described in the scientific literature (see, for example, Fromm, et al., *Proc. Natl. Acad. Sci. USA*, 82: 5824-5828 (1985)).

Various regulatory elements may be included in a construct. Any such regulatory elements may be provided in combination with other regulatory elements. Such combinations can be designed or modified to produce desirable regulatory features. Constructs of the present invention would typically comprise at least one regulatory element operably linked to a transcribable polynucleotide molecule operably linked to a 3' transcription termination molecule.

As used herein, the term "leader" refers to a DNA molecule isolated from the untranslated 5' region (5' UTR) of a genomic copy of a gene and defined generally as a segment between the transcription start site (TSS) and the coding sequence start site. Alternately, leaders may be synthetically produced or manipulated DNA elements. A leader can be used as a 5' regulatory element for modulating expression of an operably linked transcribable polynucleotide molecule. For example, non-translated 5' leaders derived from heat shock protein genes have been demonstrated to enhance gene expression in plants (see, for example, U.S. Pat. Nos. 5,659,122 and 5,362,865). Promoter molecules of the present invention may optionally comprise a native leader linked to the plant promoter segment for which it is naturally found. This molecule may be replaced with a heterologous leader.

As used herein, the term "intron" refers to a DNA molecule that may be isolated or identified from the genomic copy of a gene and may be defined generally as a region spliced out during mRNA processing prior to translation. Alternately, an intron may be a synthetically produced or manipulated DNA element. An intron may contain elements enhancer elements that effect the transcription of operably linked genes. An intron may be used as a regulatory element for modulating expression of an operably linked transcribable polynucleotide molecule. A DNA construct may comprise an intron, and the intron may or may not be heterologous with respect to the transcribable polynucleotide molecule sequence.

Examples of introns in the art include the rice actin intron (U.S. Pat. No. 5,641,876) and the corn HSP70 intron (U.S. Pat. No. 5,859,347).

As used herein, the term "3' transcription termination molecule" or "3' UTR" refers to a DNA molecule that is used during transcription to produce the 3' untranslated region (3' UTR) of an mRNA molecule. The 3' untranslated region of an mRNA molecule may be generated by specific cleavage and 3' polyadenylation, a.k.a. polyA tail. A 3' UTR may be operably linked to and located downstream of a transcribable polynucleotide molecule and may include polynucleotides that provide a polyadenylation signal and other regulatory signals capable of affecting transcription, mRNA processing, or gene expression. PolyA tails are thought to function in mRNA stability and in initiation of translation. Examples of 3' transcription termination molecules in the art are the nopaline synthase 3' region (see, Fraley, et al., *Proc. Natl. Acad. Sci. USA*, 80: 4803-4807 (1983)); wheat hsp17 3' region; pea rubisco small subunit 3' region; cotton E6 3' region (U.S. Pat. No. 6,096,950); 3' regions disclosed in WO0011200A2; and the coixin 3' UTR (U.S. Pat. No. 6,635,806).

Constructs and vectors may also include a transit peptide coding sequence that expresses a linked peptide that is useful for targeting of a protein product, particularly to a chloroplast, leucoplast, or other plastid organelle; mitochondria; peroxisome; vacuole; or an extracellular location. For descriptions of the use of chloroplast transit peptides, see U.S. Pat. No. 5,188,642 and U.S. Pat. No. 5,728,925. Many chloroplast-localized proteins are expressed from nuclear genes as precursors and are targeted to the chloroplast by a chloroplast transit peptide (CTP). Examples of such isolated chloroplast proteins include, but are not limited to, those associated with the small subunit (SSU) of ribulose-1,5-bisphosphate carboxylase, ferredoxin, ferredoxin oxidoreductase, the light-harvesting complex protein I and protein II, thioredoxin F, enolpyruvyl shikimate phosphate synthase (EPSPS), and transit peptides described in U.S. Pat. No. 7,193,133. It has been demonstrated in vivo and in vitro that non-chloroplast proteins may be targeted to the chloroplast by use of protein fusions with a heterologous CTP and that the CTP is sufficient to target a protein to the chloroplast. Incorporation of a suitable chloroplast transit peptide such as the *Arabidopsis thaliana* EPSPS CTP (CTP2) (See, Klee et al., *Mol. Gen. Genet.*, 210:437-442 (1987)) or the *Petunia hybrida* EPSPS CTP (CTP4) (See, della-Cioppa et al., *Proc. Natl. Acad. Sci. USA*, 83:6873-6877 (1986)) has been shown to target heterologous EPSPS protein sequences to chloroplasts in transgenic plants (See, U.S. Pat. Nos. 5,627,061; 5,633,435; and 5,312,910 and EP 0218571; EP 189707; EP 508909; and EP 924299).

#### Transcribable Polynucleotide Molecules

As used herein, the term "transcribable polynucleotide molecule" refers to any DNA molecule capable of being transcribed into a RNA molecule, including, but not limited to, those having protein coding sequences and those having sequences useful for gene suppression. A "transgene" refers to a transcribable polynucleotide molecule heterologous to a host cell and/or a transcribable polynucleotide molecule artificially incorporated into a host cell's genome.

A promoter of the present invention may be operably linked to a transcribable polynucleotide molecule that is heterologous with respect to the promoter molecule. As used herein, the term "heterologous" refers to the combination of two or more polynucleotide molecules when such a combination would not normally be found in nature. For example, the two molecules may be derived from different species and/or the two molecules may be derived from different

genes, e.g. different genes from the same species or the same genes from different species. A promoter is thus heterologous with respect to an operably linked transcribable polynucleotide molecule if such a combination is not normally found in nature, i.e. that transcribable polynucleotide molecule is not naturally occurring operably linked in combination with that promoter molecule.

The transcribable polynucleotide molecule may generally be any DNA molecule for which expression of an RNA transcript is desired. Such expression of an RNA transcript may result in translation of the resulting mRNA molecule and thus protein expression. Alternatively, a transcribable polynucleotide molecule may be designed to ultimately cause decreased expression of a specific gene or protein. This may be accomplished by using a transcribable polynucleotide molecule that is oriented in the antisense direction. One of ordinary skill in the art is familiar with using such antisense technology. Briefly, as the antisense transcribable polynucleotide molecule is transcribed, the RNA product hybridizes to and sequesters a complementary RNA molecule inside the cell. This duplex RNA molecule cannot be translated into a protein by the cell's translational machinery and is degraded in the cell. Any gene may be negatively regulated in this manner.

Thus, one embodiment of the invention is a chimeric promoter of the present invention, such as those provided as SEQ ID NO: 1-4, operably linked to a transcribable polynucleotide molecule so as to modulate transcription of the transcribable polynucleotide molecule at a desired level or in a desired pattern upon introduction of said construct into a plant cell. In one embodiment, the transcribable polynucleotide molecule comprises a protein-coding region of a gene, and the promoter affects the transcription of an RNA molecule that is translated and expressed as a protein product. In another embodiment, the transcribable polynucleotide molecule comprises an antisense region of a gene, and the promoter affects the transcription of an antisense RNA molecule or other similar inhibitory RNA molecule in order to inhibit expression of a specific RNA molecule of interest in a target host cell.

#### Genes of Agronomic Interest

Transcribable polynucleotide molecules may be genes of agronomic interest. As used herein, the term "gene of agronomic interest" refers to a transcribable polynucleotide molecule that when expressed in a particular plant tissue, cell, or cell type provides a desirable characteristic associated with plant morphology, physiology, growth, development, yield, product, nutritional profile, disease or pest resistance, and/or environmental or chemical tolerance. Genes of agronomic interest include, but are not limited to, those encoding a yield protein, a stress resistance protein, a developmental control protein, a tissue differentiation protein, a meristem protein, an environmentally responsive protein, a senescence protein, a hormone responsive protein, an abscission protein, a source protein, a sink protein, a flower control protein, a seed protein, an herbicide resistance protein, a disease resistance protein, a fatty acid biosynthetic enzyme, a tocopherol biosynthetic enzyme, an amino acid biosynthetic enzyme, a pesticidal protein, or any other agent such as an antisense or RNAi molecule targeting a particular gene for suppression. The product of a gene of agronomic interest may act within the plant in order to cause an effect upon the plant physiology or metabolism or may be act as a pesticidal agent in the diet of a pest that feeds on the plant.

In one embodiment of the invention, a promoter of the present invention is incorporated into a construct such that the promoter is operably linked to a transcribable polynucleotide

molecule that is a gene of agronomic interest. The expression of the gene of agronomic interest is desirable in order to confer an agronomically beneficial trait. A beneficial agronomic trait may be, for example, but not limited to, herbicide tolerance, insect control, modified yield, fungal disease resistance, virus resistance, nematode resistance, bacterial disease resistance, plant growth and development, starch production, modified oils production, high oil production, modified fatty acid content, high protein production, fruit ripening, enhanced animal and human nutrition, biopolymers, environmental stress resistance, pharmaceutical peptides and secretable peptides, improved processing traits, improved digestibility, enzyme production, flavor, nitrogen fixation, hybrid seed production, fiber production, and biofuel production. Examples of genes of agronomic interest known in the art include those for herbicide resistance (U.S. Pat. Nos. 6,803,501; 6,448,476; 6,248,876; 6,225,114; 6,107,549; 5,866,775; 5,804,425; 5,633,435; and 5,463,175), increased yield (U.S. Pat. No. USRE38,446; 6,716,474; 6,663,906; 6,476,295; 6,441,277; 6,423,828; 6,399,330; 6,372,211; 6,235,971; 6,222,098; and 5,716,837), insect control (U.S. Pat. Nos. 6,809,078; 6,713,063; 6,686,452; 6,657,046; 6,645,497; 6,642,030; 6,639,054; 6,620,988; 6,593,293; 6,555,655; 6,538,109; 6,537,756; 6,521,442; 6,501,009; 6,468,523; 6,326,351; 6,313,378; 6,284,949; 6,281,016; 6,248,536; 6,242,241; 6,221,649; 6,177,615; 6,156,573; 6,153,814; 6,110,464; 6,093,695; 6,063,756; 6,063,597; 6,023,013; 5,959,091; 5,942,664; 5,942,658; 5,880,275; 5,763,245; and 5,763,241), fungal disease resistance (U.S. Pat. Nos. 6,653,280; 6,573,361; 6,506,962; 6,316,407; 6,215,048; 5,516,671; 5,773,696; 6,121,436; 6,316,407; and 6,506,962), virus resistance (U.S. Pat. Nos. 6,617,496; 6,608,241; 6,015,940; 6,013,864; 5,850,023; and 5,304,730), nematode resistance (U.S. Pat. No. 6,228,992), bacterial disease resistance (U.S. Pat. No. 5,516,671), plant growth and development (U.S. Pat. Nos. 6,723,897 and 6,518,488), starch production (U.S. Pat. Nos. 6,538,181; 6,538,179; 6,538,178; 5,750,876; 6,476,295), modified oils production (U.S. Pat. Nos. 6,444,876; 6,426,447; and 6,380,462), high oil production (U.S. Pat. Nos. 6,495,739; 5,608,149; 6,483,008; and 6,476,295), modified fatty acid content (U.S. Pat. Nos. 6,828,475; 6,822,141; 6,770,465; 6,706,950; 6,660,849; 6,596,538; 6,589,767; 6,537,750; 6,489,461; and 6,459,018), high protein production (U.S. Pat. No. 6,380,466), fruit ripening (U.S. Pat. No. 5,512,466), enhanced animal and human nutrition (U.S. Pat. Nos. 6,723,837; 6,653,530; 6,541,259; 5,985,605; and 6,171,640), biopolymers (U.S. Pat. Nos. USRE37,543; 6,228,623; and 5,958,745, and 6,946,588), environmental stress resistance (U.S. Pat. No. 6,072,103), pharmaceutical peptides and secretable peptides (U.S. Pat. Nos. 6,812,379; 6,774,283; 6,140,075; and 6,080,560), improved processing traits (U.S. Pat. No. 6,476,295), improved digestibility (U.S. Pat. No. 6,531,648) low raffinose (U.S. Pat. No. 6,166,292), industrial enzyme production (U.S. Pat. No. 5,543,576), improved flavor (U.S. Pat. No. 6,011,199), nitrogen fixation (U.S. Pat. No. 5,229,114), hybrid seed production (U.S. Pat. No. 5,689,041), fiber production (U.S. Pat. Nos. 6,576,818; 6,271,443; 5,981,834; and 5,869,720) and biofuel production (U.S. Pat. No. 5,998,700).

Alternatively, a gene of agronomic interest can affect the above mentioned plant characteristic or phenotype by encoding a RNA molecule that causes the targeted modulation of gene expression of an endogenous gene, for example via antisense (See, e.g., U.S. Pat. No. 5,107,065); inhibitory RNA ("RNAi", including modulation of gene expression via miRNA-, siRNA-, trans-acting siRNA-, and phased siRNA-mediated mechanisms, e.g., as described in published appli-

cations US 2006/0200878 and US 2008/0066206, and in U.S. patent application Ser. No. 11/974,469); or cosuppression-mediated mechanisms. The RNA could also be a catalytic RNA molecule (e.g., a ribozyme or a riboswitch; see e.g., US 2006/0200878) engineered to cleave a desired endogenous mRNA product. Thus, any transcribable polynucleotide molecule that encodes a transcribed RNA molecule that affects an agronomically important phenotype or morphology change of interest may be useful for the practice of the present invention. Methods are known in the art for constructing and introducing constructs into a cell in such a manner that the transcribable polynucleotide molecule is transcribed into a molecule that is capable of causing gene suppression. For example, posttranscriptional gene suppression using a construct with an anti-sense oriented transcribable polynucleotide molecule to regulate gene expression in plant cells is disclosed in U.S. Pat. Nos. 5,107,065 and 5,759,829, and posttranscriptional gene suppression using a construct with a sense-oriented transcribable polynucleotide molecule to regulate gene expression in plants is disclosed in U.S. Pat. Nos. 5,283,184 and 5,231,020. Expression of a transcribable polynucleotide in a plant cell can also be used to suppress plant pests feeding on the plant cell, for example, compositions isolated from coleopteran pests (U.S. Patent Publication No. US2007/0124836) and compositions isolated from nematode pests (U.S. Patent Publication No. US2007/0250947). Plant pests include, but are not limited to arthropod pests, nematode pests, and fungal or microbial pests. Exemplary transcribable polynucleotide molecules for incorporation into constructs of the present invention include, for example, DNA molecules or genes from a species other than the target species or genes that originate with or are present in the same species, but are incorporated into recipient cells by genetic engineering methods rather than classical reproduction or breeding techniques. The type of polynucleotide molecule can include, but is not limited to, a polynucleotide molecule that is already present in the plant cell, a polynucleotide molecule from another plant, a polynucleotide molecule from a different organism, or a polynucleotide molecule generated externally, such as a polynucleotide molecule containing an antisense message of a gene, or a polynucleotide molecule encoding an artificial, synthetic, or otherwise modified version of a transgene.

#### Selectable Markers

As used herein the term "marker" refers to any transcribable polynucleotide molecule whose expression, or lack thereof, can be screened for or scored in some way. Marker genes for use in the practice of the present invention include, but are not limited to transcribable polynucleotide molecules encoding  $\beta$ -glucuronidase (GUS described in U.S. Pat. No. 5,599,670), green fluorescent protein and variants thereof (GFP described in U.S. Pat. Nos. 5,491,084 and 6,146,826), proteins that confer antibiotic resistance, or proteins that confer herbicide tolerance. Useful antibiotic resistance markers, including those encoding proteins conferring resistance to kanamycin (nptII), hygromycin B (aph IV), streptomycin or spectinomycin (aad, spec/strep) and gentamycin (aac3 and aacC4) are known in the art. Herbicides for which transgenic plant tolerance has been demonstrated and the method of the present invention can be applied, include, but are not limited to: amino-methyl-phosphonic acid, glyphosate, glufosinate, sulfonylureas, imidazolinones, bromoxynil, dalapon, dicamba, cyclohexanedione, protoporphyrinogen oxidase inhibitors, and isoxaflutole herbicides. Transcribable polynucleotide molecules encoding proteins involved in herbicide tolerance are known in the art, and include, but are not limited to, a transcribable polynucleotide molecule encoding

5-enolpyruvylshikimate-3-phosphate synthase (EPSPS for glyphosate tolerance described in U.S. Pat. Nos. 5,627,061; 5,633,435; 6,040,497; and 5,094,945); a transcribable polynucleotide molecule encoding a glyphosate oxidoreductase and a glyphosate-N-acetyl transferase (GOX described in U.S. Pat. No. 5,463,175; GAT described in U.S. Patent publication No. 20030083480, and dicamba monooxygenase U.S. Patent publication No. 20030135879); a transcribable polynucleotide molecule encoding bromoxynil nitrilase (Bxn for Bromoxynil tolerance described in U.S. Pat. No. 4,810,648); a transcribable polynucleotide molecule encoding phytoene desaturase (crtI) described in Misawa, et al., *Plant Journal*, 4:833-840 (1993) and Misawa, et al., *Plant Journal*, 6:481-489 (1994) for norflurazon tolerance; a transcribable polynucleotide molecule encoding acetohydroxyacid synthase (AHAS, aka ALS) described in Sathasiivan, et al., *Nucl. Acids Res.*, 18:2188-2193 (1990) for tolerance to sulfonylurea herbicides; and the bar gene described in DeBlock, et al., *EMBO Journal*, 6:2513-2519 (1987) for glufosinate and bialaphos tolerance. The promoter molecules of the present invention can express linked transcribable polynucleotide molecules that encode for phosphinothricin acetyltransferase, glyphosate resistant EPSPS, aminoglycoside phosphotransferase, hydroxyphenyl pyruvate dehydrogenase, hygromycin phosphotransferase, neomycin phosphotransferase, dalapon dehalogenase, bromoxynil resistant nitrilase, anthranilate synthase, aryloxyalkanoate dioxygenases, acetyl CoA carboxylase, glyphosate oxidoreductase, and glyphosate-N-acetyl transferase.

Included within the term "selectable markers" are also genes which encode a secretable marker whose secretion can be detected as a means of identifying or selecting for transformed cells. Examples include markers that encode a secretable antigen that can be identified by antibody interaction, or even secretable enzymes which can be detected catalytically. Selectable secreted marker proteins fall into a number of classes, including small, diffusible proteins which are detectable, (e.g., by ELISA), small active enzymes which are detectable in extracellular solution (e.g., alpha-amylase, beta-lactamase, phosphinothricin transferase), or proteins which are inserted or trapped in the cell wall (such as proteins which include a leader sequence such as that found in the expression unit of extension or tobacco pathogenesis related proteins also known as tobacco PR-S). Other possible selectable marker genes will be apparent to those of skill in the art and are encompassed by the present invention.

#### Cell Transformation

The invention is also directed to a method of producing transformed cells and plants which comprise a promoter operably linked to a transcribable polynucleotide molecule.

The term "transformation" refers to the introduction of nucleic acid into a recipient host. As used herein, the term "host" refers to bacteria, fungi, or plant, including any cells, tissue, organs, or progeny of the bacteria, fungi, or plant. Plant tissues and cells of particular interest include protoplasts, calli, roots, tubers, seeds, stems, leaves, seedlings, embryos, and pollen.

As used herein, the term "transformed" refers to a cell, tissue, organ, or organism into which a foreign polynucleotide molecule, such as a construct, has been introduced. The introduced polynucleotide molecule may be integrated into the genomic DNA of the recipient cell, tissue, organ, or organism such that the introduced polynucleotide molecule is inherited by subsequent progeny. A "transgenic" or "transformed" cell or organism also includes progeny of the cell or organism and progeny produced from a breeding program employing such a transgenic organism as a parent in a cross

and exhibiting an altered phenotype resulting from the presence of a foreign polynucleotide molecule. The term "transgenic" refers to a bacteria, fungi, or plant containing one or more heterologous polynucleic acid molecules.

There are many methods for introducing polynucleic acid molecules into plant cells. The method generally comprises the steps of selecting a suitable host cell, transforming the host cell with a recombinant vector, and obtaining the transformed host cell. Suitable methods include bacterial infection (e.g. *Agrobacterium*), binary bacterial artificial chromosome vectors, direct delivery of DNA (e.g. via PEG-mediated transformation, desiccation/inhibition-mediated DNA uptake, electroporation, agitation with silicon carbide fibers, and acceleration of DNA coated particles, etc. (reviewed in Potrykus, et al., *Ann. Rev. Plant Physiol. Plant Mol. Biol.*, 42: 205 (1991)).

Technology for introduction of a DNA molecule into cells is well known to those of skill in the art. Methods and materials for transforming plant cells by introducing a plant DNA construct into a plant genome in the practice of this invention can include any of the well-known and demonstrated methods including, but not limited to:

- (1) chemical methods (Graham and Van der Eb, *Virology*, 54(2):536-539 (1973) and Zatloukal, et al., *Ann. N.Y. Acad. Sci.*, 660: 136-153 (1992));
- (2) physical methods such as microinjection (Capecchi, *Cell*, 22(2):479-488 (1980)), electroporation (Wong and Neumann, *Biochim. Biophys. Res. Commun.*, 107(2): 584-587 (1982); Fromm, et al., *Proc. Natl. Acad. Sci. USA*, 82(17):5824-5828 (1985); U.S. Pat. No. 5,384,253) particle acceleration (Johnston and Tang, *Methods Cell Biol.*, 43(A):353-365 (1994); Fynan, et al., *Proc. Natl. Acad. Sci. USA*, 90(24):11478-11482 (1993)); and microprojectile bombardment (as illustrated in U.S. Pat. Nos. 5,015,580; 5,550,318; 5,538,880; 6,160,208; 6,399,861; and 6,403,865);
- (3) viral vectors (Clapp, *Clin. Perinatol.*, 20(1):155-168 (1993); Lu, et al., *J. Exp. Med.*, 178(6):2089-2096 (1993); Eglitis and Anderson, *Biotechniques*, 6(7):608-614 (1988));
- (4) receptor-mediated mechanisms (Curiel et al., *Hum. Gen. Ther.*, 3(2):147-154 (1992) and Wagner, et al., *Proc. Natl. Acad. Sci. USA*, 89(13):6099-6103 (1992);
- (5) bacterial mediated mechanisms such as *Agrobacterium*-mediated transformation (as illustrated in U.S. Pat. Nos. 5,824,877; 5,591,616; 5,981,840; and 6,384,301);
- (6) direct introduction into pollen by injecting a plant's reproductive organs (Zhou, et al., *Methods in Enzymology*, 101:433, (1983); Hess, *Intern. Rev. Cytol.*, 107:367 (1987); Luo, et al., *Plant Mol. Biol. Reporter*, 6:165 (1988); Pena, et al., *Nature*, 325:274 (1987));
- (7) protoplast transformation (as illustrated in U.S. Pat. No. 5,508,184); and
- (8) injection into immature embryos (Neuhaus, et al., *Theor. Appl. Genet.*, 75:30 (1987)).

Any of the above described methods may be utilized to transform a host cell with one or more promoters and/or constructs of the present. Host cells may be any cell or organism such as a plant cell, algae cell, algae, fungal cell, fungi, bacterial cell, or insect cell. Preferred hosts and transformed cells include cells from: plants, *Aspergillus*, yeasts, insects, bacteria and algae.

Methods for transforming dicotyledonous plants, primarily by use of *Agrobacterium tumefaciens* and obtaining transgenic plants have been published for cotton (U.S. Pat. Nos. 5,004,863; 5,159,135; and 5,518,908); soybean (U.S. Pat. Nos. 5,569,834 and 5,416,011; see also, McCabe, et al.,

*Biotechnology*, 6:923 (1988) and Christou et al., *Plant Physiol.* 87:671-674 (1988)); *Brassica* (U.S. Pat. No. 5,463,174); peanut (Cheng et al., *Plant Cell Rep.*, 15:653-657 (1996) and McKently et al., *Plant Cell Rep.*, 14:699-703 (1995)); papaya; and pea (Grant et al., *Plant Cell Rep.*, 15:254-258 (1995)).

Transformations of monocotyledon plants using electroporation, particle bombardment, and *Agrobacterium* have also been reported. Transformation and plant regeneration have been achieved in asparagus (Bytebier, et al., *Proc. Natl. Acad. Sci. (USA)*, 84:5354 (1987); barley (Wan and Lemaux, *Plant Physiol.*, 104:37 (1994)); maize (Rhodes, et al., *Science* 240: 204 (1988), Gordon-Kamm, et al., *Plant Cell*, 2:603-618 (1990), Fromm, et al., *Bio/Technology*, 8:833 (1990), Kozziel et al., *Bio/Technology*, 11:194 (1993), and Armstrong, et al., *Crop Science*, 35:550-557 (1995)); oat (Somers, et al., *Bio/Technology*, 10:1589 (1992)); orchard grass (Horn, et al., *Plant Cell Rep.* 7:469 (1988)); rye (De la Pena, et al., *Nature*, 325:274 (1987)); sugarcane (Bower and Birch, *Plant Journal*, 2:409 (1992)); tall fescue (Wang, et al., *Bio/Technology*, 10:691 (1992)); and wheat (Vasil, et al., *Bio/Technology*, 10:667 (1992) and U.S. Pat. No. 5,631,152).

The regeneration, development, and cultivation of plants from transformed plant protoplast or explants is well known in the art (see, for example, Weissbach and Weissbach, *Methods for Plant Molecular Biology*, (Eds.), Academic Press, Inc., San Diego, Calif. (1988) and Horsch et al., *Science*, 227:1229-1231 (1985)). Transformed cells are generally cultured in the presence of a selective media, which selects for the successfully transformed cells and induces the regeneration of plant shoots and roots into intact plants (Fraley, et al., *Proc. Natl. Acad. Sci. U.S.A.*, 80: 4803 (1983)). Transformed plants are typically obtained within two to four months.

The regenerated transgenic plants are self-pollinated to provide homozygous transgenic plants. Alternatively, pollen obtained from the regenerated transgenic plants may be crossed with non-transgenic plants, preferably inbred lines of agronomically important species. Descriptions of breeding methods that are commonly used for different traits and crops can be found in one of several reference books, see, for example, Allard, *Principles of Plant Breeding*, John Wiley & Sons, NY, U. of CA, Davis, Calif., 50-98 (1960); Simmonds, *Principles of crop improvement*, Longman, Inc., NY, 369-399 (1979); Snee and Hendriksen, *Plant breeding perspectives*, Wageningen (ed), Center for Agricultural Publishing and Documentation (1979); Fehr, *Soybeans: Improvement, Production and Uses*, 2nd Edition, Monograph., 16:249 (1987); Fehr, *Principles of variety development, Theory and Technique*, (Vol 1) and *Crop Species Soybean* (Vol 2), Iowa State Univ., Macmillan Pub. Co., NY, 360-376 (1987). Conversely, pollen from non-transgenic plants may be used to pollinate the regenerated transgenic plants.

The transformed plants may be analyzed for the presence of the genes of interest and the expression level and/or profile conferred by the regulatory elements of the present invention. Those of skill in the art are aware of the numerous methods available for the analysis of transformed plants. For example, methods for plant analysis include, but are not limited to Southern blots or northern blots, PCR-based approaches, biochemical analyses, phenotypic screening methods, field evaluations, and immunodiagnostic assays. The expression of a transcribable polynucleotide molecule can be measured using TaqMan® (Applied Biosystems, Foster City, Calif.) reagents and methods as described by the manufacturer and PCR cycle times determined using the TaqMan® Testing Matrix. Alternatively, the Invader® (Third Wave Technolo-

gies, Madison, Wis.) reagents and methods as described by the manufacturer can be used transgene expression.

The seeds of the plants of this invention can be harvested from fertile transgenic plants and be used to grow progeny generations of transformed plants of this invention including hybrid plant lines comprising the construct of this invention and expressing a gene of agronomic interest.

The present invention also provides for parts of the plants of the present invention. Plant parts, without limitation, include leaves, stems, roots, tubers, seeds, endosperm, ovule, and pollen. The invention also includes and provides transformed plant cells which comprise a nucleic acid molecule of the present invention.

The transgenic plant may pass along the transgenic polynucleotide molecule to its progeny. Progeny includes any regenerable plant part or seed comprising the transgene derived from an ancestor plant. The transgenic plant is preferably homozygous for the transformed polynucleotide molecule and transmits that sequence to all offspring as a result of sexual reproduction. Progeny may be grown from seeds produced by the transgenic plant. These additional plants may then be self-pollinated to generate a true breeding line of plants. The progeny from these plants are evaluated, among other things, for gene expression. The gene expression may be detected by several common methods such as western blotting, northern blotting, immuno-precipitation, and ELISA.

Having now generally described the invention, the same will be more readily understood through reference to the following examples which are provided by way of illustration, and are not intended to be limiting of the present invention, unless specified. It should be appreciated by those of skill in the art that the techniques disclosed in the following examples represent techniques discovered by the inventors to function well in the practice of the invention. However, those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments that are disclosed and still obtain a like or similar result without departing from the spirit and scope of the invention, therefore all matter set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

## EXAMPLES

Chimeric promoters useful to drive expression of an operably linked transcribable polynucleotide in transgenic plants were constructed, and the expression pattern of these promoters was analyzed in transgenic plants.

### Example 1

#### Construction of Chimeric Promoters

Chimeric promoters are created by fusing at least one enhancer element isolated from a napin promoter of *Brassica* with a promoter. Enhancer elements isolated from a napin promoter of *Brassica* and useful in practicing the invention are provided as SEQ ID NO:19-35. The chimeric promoter is constructed with at least one enhancer element provided in SEQ ID NOs: 19-35, but may have two or more copies of any enhancer element or combination of enhancer elements provided in SEQ ID NOs:19-35. The enhancer element can be inserted as a DNA fragment at any location within the promoter molecule or fused at the 5' or 3' end of the promoter molecule. A chimeric promoter may optionally contain additional polynucleotides such as those having DNA sequences

for restrictions endonuclease sites, recombination sites, or ligation-independent cloning sites. These additional polynucleotides may optionally be located between an enhancer element and the promoter.

Promoters useful in practicing the invention include any promoter capable of expressing an operably linked transcribable polynucleotide molecule in plants. An example of promoters useful in practicing the invention would be native napin promoters. A native napin promoter includes any promoter derived from the 5' end of a genomic copy of a napin gene. A napin gene is a gene encoding a napin protein. Napin proteins are a family of low-molecular weight basic seed storage proteins synthesized in the embryo during seed maturation. Examples of native napin promoters useful in practicing the invention are provided as SEQ ID NO:6-17. Further examples of promoters useful in practicing the invention would include any promoter derived from the 5' end of a genomic copy of an actin gene, such as the *Arabidopsis thaliana* Act7 promoter (SEQ ID NO:18) and other actin promoters known in the art, see for example U.S. Pat. No. 7,408,054 and PCT Publication No. WO 01/44457.

Two chimeric promoters, referred to herein as short e-napin (SEQ ID NO:1) and long e-napin (SEQ ID NO:2), were created by combining a native napin promoter with an enhancer element isolated from the native napin promoter. The short e-napin chimeric promoter (SEQ ID NO:1) was constructed by combining an enhancer element (SEQ ID NO:19) with a native napin promoter (SEQ ID NO:7). The short e-napin promoter plus leader (SEQ ID NO:3) is comprised of the short e-napin promoter (SEQ ID NO:1) and a napin leader (SEQ ID NO:5) contiguously arranged in the 5' to 3' direction. The long e-napin chimeric promoter (SEQ ID NO:2) was constructed by combining an enhancer element (SEQ ID NO:27) with a native napin promoter (SEQ ID NO:7). The long e-napin promoter plus leader (SEQ ID NO:4) is comprised of the long e-napin promoter (SEQ ID NO:2) and a napin leader (SEQ ID NO:5) contiguously arranged in the 5' to 3' direction. The native napin promoter plus leader (SEQ ID NO:6) is comprised of a native napin promoter (SEQ ID NO:7) and a short leader sequence (SEQ ID NO:5) contiguously arranged in the 5' to 3' direction.

A chimeric promoter comprising a native actin promoter may be created by combining a native actin promoter with at least one enhancer element provided as SEQ ID NO:19-35 using methods to manipulate DNA molecules well known in the art. For example, a single enhancer element provided as SEQ ID NO:19 may be inserted within the *A. thaliana* Actin 7 promoter (SEQ ID NO:18). Such insertion may be between the core promoter element and leader of the *A. thaliana* Actin 7 promoter. The resulting sequence, referred to herein as the short e-actin 7 promoter, is provided as SEQ ID NO:36. Likewise, a single enhancer element provided as SEQ ID NO:27 may be inserted within the *A. thaliana* Actin 7 promoter (SEQ ID NO:18) between the core promoter element and leader of the promoter. The resulting sequence, referred to herein as the long e-actin 7 promoter, is provided as SEQ ID NO:37. Other chimeric promoters comprising the *A. thaliana* Actin 7 promoter may be made by using one or more of the enhancer elements SEQ ID NO:19-35.

Chimeric promoters may be operably linked to a transcribable polynucleotide sequence in a plant transformation construct. The plant transformation construct can be used to produce transgenic plants or in a transient protoplast assay from protoplasts derived from plant tissue to analyze the expression pattern of the chimeric promoter.

## GUS Expression Analysis

Canola plants were transformed with plant transformation vectors containing the native napin promoter (pMON82357), the short e-napin promoter (pMON72629), and the long e-napin promoter (pMON72630), respectively, each driving the expression of an *E. coli* beta-glucuronidase gene (GUS, described in U.S. Pat. No. 5,599,670) to evaluate the synthetic enhanced promoters.

Canola plants (*Brassica napus*) were transformed using a modification of the protocol described by Radke et al., (*Plant Cell Reports* 11:499-505, 1992). Briefly, canola seed of the cultivar 'Ebony' (Monsanto Canada, Inc., Winnipeg, Canada) was disinfected and germinated in vitro as described in Radke et al., 1992. Pre-cocultivation with tobacco feeder plates, explant preparation, and inoculation of explants with *Agrobacterium tumefaciens* strain ABI (Koncz and Schell, *Mol Gen Genet.* 204:383-396 (1986)) containing the vector pMON72629, pMON72630, or pMON82357 was done as described with the *Agrobacterium* being maintained in LB media (solid or liquid) containing 75 mg/l spectinomycin, 25 mg/liter chloramphenicol and 50 mg/liter kanamycin. For plant transformation including callus induction, shoot regeneration, maturation, and rooting, glyphosate selection was used. Specifically, the B5-1 callus induction medium was supplemented with 500 mg/liter carbenicillin and 50 mg/liter Timentin (Duchefa Biochemie BV) to inhibit the *Agrobacterium* growth and kanamycin was omitted from the media. B5BZ shoot regeneration medium contained 500 mg/liter carbenicillin, 50 mg/liter, Timentin and 45 mg/liter glyphosate with explants being transferred to fresh medium every two weeks. Glyphosate-selected shoots were transferred to hormone-free B5-0 shoot maturation medium containing 300 mg/liter carbenicillin and 45 mg/liter glyphosate for two weeks; and shoots were transferred to B5 root induction medium containing 45 mg/l glyphosate. Rooted green plantlets were transplanted to potting soil and acclimated to greenhouse conditions. Plants were maintained in a greenhouse under standard conditions. Developing seed was harvested at various stages after pollination and stored at -70° C. Mature seed was collected and stored under controlled conditions consisting of about 17° C. and 30% humidity.

GUS activity was qualitatively and quantitatively measured using methods known to those skilled in the art. In the qualitative analysis, plant tissue samples were collected from the roots, stems, leaves, flowers and developing pods. For the quantitative analysis, tissues were obtained from whole isolated seeds.

For qualitative GUS analysis, whole tissue sections were incubated with the GUS staining solution X-Gluc (5-bromo-4-chloro-3-indolyl- $\beta$ -glucuronide) (1 milligram/milliliter) for an appropriate length of time, rinsed, and visually inspected for blue staining. For all three constructs, GUS expression was not observed in the roots, leaves, or stems of the transformed canola plants. Plants transformed with either the short e-napin (pMON72629) promoter or long e-napin (pMON72630) promoter demonstrated expression in the seed, while all but one event transformed with the native napin (pMON82357) promoter showed no expression in the seed. In the qualitative analysis, seed expression was determined by viewing GUS staining of the seed through the developing pods. Visible staining may not have been intense enough in the native napin promoter constructs to view seed expression through the pod tissues. Qualitative GUS analysis

results are described in Table 1 below. Non-transformed canola plants were used as a negative control for comparison.

TABLE 1

Qualitative GUS Expression Analysis for Transformed Canola Events	
Observed Staining	
<b>pMON82357</b>	
Event 1	Septum, Funiculus
Event 2	Septum, Funiculus
Event 3	Septum, Funiculus, Silique Wall,
Event 4	Septum, Funiculus, Stigma,
Event 5	Septum, Funiculus
Event 6	Septum, Funiculus
Event 7	Septum, Funiculus
Event 8	Septum, Funiculus, Filament, Nectarie
Event 9	Septum, Funiculus, Filament, Nectarie
Event 10	Septum, Funiculus
Event 11	Septum, Funiculus, Nectarie
Event 12	Septum, Funiculus
Event 13	Septum, Funiculus, Seed (weakly stained)
<b>pMON72629</b>	
Event 1	Seed
Event 2	Seed, Silique
Event 3	Seed (weak), Inner Membrane
Event 4	Seed, Inner Membrane and Cut Sites
Event 5	Silique, Inner Membrane, Funiculus, Seed (all strong staining)
Event 6	Seed
Event 7	Inner Membrane (faint), 1 seed coat (weak)
Event 8	Funiculus, maybe 1 seed
Event 9	Silique (weak), Inner Membrane, Seed
Event 10	Silique, Inner Membrane, Seed
Event 11	Seed, Inner Membrane
Event 12	Seed and Funiculus
Event 13	Silique, Inner Membrane, Cut Sites, 1 cut Seed
Event 14	none
Event 15	Seed, slight Inner Membrane
<b>pMON72630</b>	
Event 1	none
Event 2	Silique and Seed
Event 3	Cut Sites, Funiculus, Seed (very weak)
Event 4	Funiculus
Event 5	Seed, slight Silique
Event 6	Silique and Seed (weak)
Event 7	Seed and Inner Membrane
Event 8	Seed, Funiculus, Inner Membrane
Event 9	Seed, Inner Membrane (not in 2nd well of seeds alone)
Event 10	Seed, Funiculus, Cut Site
Event 11	Heavy in Seed, Silique, Inner Membrane
Event 12	Inner Membrane, Seed, slight Silique
Event 13	Seed
Event 14	Seed, Funiculus, Cut Site
Event 15	Seed, faint Inner Membrane
Event 16	Faint Funiculus, Multiple seed blue at funiculus attachment point
Event 17	Seed, Funiculus, Silique
<b>Negative Controls</b>	
Event C1	none
Event C2	none
Event C3	none
Event C4	none
Event C5	none
Event C6	none
Event C7	none
Event C8	none

For quantitative analysis, total protein was extracted from the seed of transformed canola plants when the seeds were near or at maturity. One microgram of total protein was used with the fluorogenic substrate 4-methylumbelliferyl- $\beta$ -D-

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glucuronide (MUG) in a total reaction volume of 50 microliters. The reaction product, 4-methylumbelliferone (4-MU), is maximally fluorescent at high pH, where the hydroxyl group is ionized. Addition of a basic solution of sodium carbonate simultaneously stops the assay and adjusts the pH for quantifying the fluorescent product. Fluorescence was measured with excitation at 365 nm, emission at 445 nm using a FluoroMax®-3 spectrofluorometer with MicroMax Reader (Horiba Jobin Yvon, Inc., Edison, N.J.), with slit width set at excitation 2 nm and emission 3 nm. Table 2 below shows the GUS activity expressed as pmole of 4-MU/microliter. This data is also depicted in FIG. 1 (Average GUS activity in pmoles/microliter for each construct). Non-transformed canola plants were used as a negative control for comparison.

In the quantitative assay, expression of GUS in the seed can be observed in those events presented in the qualitative analysis in which seed expression appeared to be lacking or too low to be detected by visual inspection. This is likely due to several factors. The quantitative analysis only used seeds isolated from pods which were harvested at a later maturity stage than seeds within the pod in the qualitative analysis. In addition, the quantitative assay is more sensitive and does not rely on visual perception of the staining of the seed through the pod tissue. The sample used for the quantitative assay was comprised solely of seed tissue and hence detection of GUS activity within the seed would be more easily detected, even at levels that may not be easily perceived through visual inspection. The qualitative analysis however, provides a general overview of the expression profile that is derived when using either the native napin promoter or short e-napin promoter or long e-napin promoter.

GUS activity in the seed and seed-associated tissue extracts was on average higher when transgene expression was driven by the short e-napin (pMON72629) and long e-napin (pMON72630) promoter than when driven by the native napin (pMON82357) promoter. GUS activity on average for the short e-napin promoter (SEQ ID NO:1) was 75.38 pmole/ml; GUS activity on average for the long e-napin promoter (SEQ ID NO:2) was 58.92 pmole/ml; and GUS activity on average for the native napin promoter (SEQ ID NO:7) was 37.94 pmole/ml. The short e-napin promoter thus gave a 1.98 fold increase in GUS activity over the native napin promoter, and the long e-napin promoter gave a 1.55 fold increase in GUS activity over the native napin promoter.

TABLE 2

Quantitative GUS Expression for Transformed Canola Events	
Construct	GUS Activity (pmole/ml)
PMON72629 Event 1	58.524
PMON72629 Event 2	18.215
PMON72629 Event 3	100.143
PMON72629 Event 4	88.652
PMON72629 Event 5	95.497
PMON72629 Event 6	60.035
PMON72629 Event 7	132.444
PMON72629 Event 8	104.981
PMON72629 Event 9	71.7
PMON72629 Event 10	71.678
PMON72629 Event 11	67.294
PMON72629 Event 12	124.145
PMON72629 Event 13	45.256
PMON72629 Event 14	<LOD
PMON72629 Event 15	92.261
PMON72629	75.38
Average Expression	

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TABLE 2-continued

Quantitative GUS Expression for Transformed Canola Events	
Construct	GUS Activity (pmole/ml)
PMON72630 Event 1	<LOD
PMON72630 Event 2	93.264
PMON72630 Event 3	29.879
PMON72630 Event 4	49.689
PMON72630 Event 5	86.641
PMON72630 Event 6	57.212
PMON72630 Event 7	54.619
PMON72630 Event 8	50.099
PMON72630 Event 9	15.057
PMON72630 Event 10	24.564
PMON72630 Event 11	131.072
PMON72630 Event 12	88.762
PMON72630 Event 13	23.959
PMON72630 Event 14	81.494
PMON72630 Event 15	103.698
PMON72630 Event 16	19.339
PMON72630 Event 17	92.248
PMON72630	58.92
Average Expression	
PMON82357 Event 1	0.257
PMON82357 Event 2	47.421
PMON82357 Event 3	75.546
PMON82357 Event 4	50.387
PMON82357 Event 5	38.605
PMON82357 Event 6	39.544
PMON82357 Event 7	14.416
PMON82357 Event 8	23.487
PMON82357 Event 9	37.720
PMON82357 Event 10	123.013
PMON82357 Event 11	6.425
PMON82357 Event 12	21.058
PMON82357 Event 13	15.393
PMON82357	37.94
Average Expression	
Negative Control Event C1	56.545
Negative Control Event C2	<LOD
Negative Control Event C3	<LOD
Negative Control Event C4	<LOD
Negative Control Event C5	<LOD
Negative Control Event C6	<LOD
Negative Control Event C7	18.999
Negative Control Event C8	<LOD
Negative Control	9.44
Average Expression	

## Example 3

## Agronomic Trait Analysis

The enhanced napin promoters were analyzed for their ability to drive expression of a gene of interest for an agronomic trait. Two constructs were engineered to contain an enhanced napin promoter driving expression of genes that are in the fatty acid biosynthetic pathway in order to introduce genes coding for the enzymes that would reduce levels of saturated fatty acids in the seeds.

Fatty acid biosynthesis takes place in the plastid of the plant cell where the KAS enzymes ( $\beta$ -ketoacyl-acyl synthetases) are the rate limiting enzymes that catalyze the conversion of the growing fatty acid (FA) chain. KAS I catalyzes conversion to palmitic acid and KAS IV catalyzes conversion to stearic acid. Delta 9-desaturase converts stearic acid to oleic acid. The growing FA chain is attached to an acyl carrier protein (ACP), which is then removed by one of 2 thioesterases, either FAT B or FAT A, prior to export of the FA into the cytosol. Here a CoA moiety attaches to the FA which eventually is incorporated into the triacylglycerol (TAG) backbone to form oil bodies. FIG. 2 depicts this pathway diagrammatically.

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The two genes that encode the fatty acid biosynthetic enzymes ketoacyl-acyl-synthases, KAS I and KAS IV from the genus *Cuphea pulcherrima*, (PCT Publication WO1998/46776), and a third gene, Delta-9-Desaturase from Castor bean (*Ricinus communis*, U.S. Pat. No. 5,723,595), were operably linked with the napin promoter, the short e-napin promoter, or the long e-napin promoter in plant transformation constructs. FIG. 3 depicts the arrangement of pMON72614, pMON72615, and pMON72616. These constructs contain four coding sequences, each with its own operably linked regulatory elements. The left border sequence is indicated as "LB"; a selection cassette for glyphosate tolerance is indicated as "Glyphosate Selection Cassette"; a cassette for expression of the D9-desaturase enzyme containing the native napin promoter (indicated as "P1"), operably linked to the D9-desaturase coding sequence (indicated as "D9"), operably linked to the native napin 3' UTR (indicated as "U1") is indicated as "D9-desaturase Cassette"; a KASIV cassette for the expression of the KASIV enzyme containing either the native napin promoter (pMON72614), the long e-napin promoter (pMON72615), or the short e-napin promoter (pMON72616) each indicated as "P2", operably linked to the KASIV coding sequence (indicated as "KASIV"), operably linked to the native napin 3' UTR (indicated as "U2") is indicated as "KASIV Cassette"; a KASI cassette for the expression of the KASI enzyme containing either the native napin promoter (pMON72614), the long e-napin promoter (pMON72615), or the short e-napin promoter (pMON72616) indicated as "P3", operably linked to the KASI coding sequence (indicated as KASI), operably linked to the native napin 3' UTR (indicated as "U3") is indicated as "KASI Cassette"; and the right border sequence is indicated as "RB".

These constructs were used to transform canola plants as described above. One hundred events of transformed canola plants were generated for each construct. Gene and molecular analysis for the presence of each gene of interest and the selectable marker was conducted. Events that were positive for both gene of interest and the selectable marker and that had one copy of the selectable marker were grown in a greenhouse. R1 seed was collected at maturity and 20 single seeds per event were analyzed by fatty acid methyl ester FAME/GC for fatty acid composition.

Plants from six events transformed with the construct containing the long e-napin promoter driving the KAS I and KAS IV genes (pMON72615) exhibited saturate levels below 5%. These plants were single copy for the selectable marker, and therefore single copy for the genes of interest, and segregated in a 3:1 distribution pattern. Plants from three events transformed with the construct containing the short e-napin promoter driving the KAS I and KAS IV genes (pMON72616) exhibited saturate levels below 5%. These plants were single copy for the selectable marker, and therefore single copy for the genes of interest, and segregated in a 3:1 distribution pattern. Plants from six events transformed with the construct containing the native napin promoter driving the KAS I and KAS IV genes (pMON72614) exhibited saturate levels below 5%. These plants were single copy for the selectable marker, and therefore single copy for the genes of interest, and segregated in a 3:1 distribution pattern.

All of these events germinated and were carried forward. Seed from the transformed canola plants was analyzed for 16:0 and 18:0 saturated fatty acid content to determine the saturate levels. A low saturate phenotype was defined as >3.5% but <6% of combined levels of 16:0+18:0 saturated fatty acids. A very low saturate phenotype also known as a "zero saturate phenotype" was defined as <3.5% combined

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levels of 16:0+18:0 saturated fatty acids. Data is provided in Table 3 below. Non-transformed canola plants were used as a negative control for comparison.

Saturate levels in the canola seed were on average higher when the KAS I and KAS IV genes were driven by the native napin promoter (pMON72614) than when driven by the long e-napin promoter (pMON72615) or the short e-napin promoter (pMON72616). The combined levels of 16:0+18:0 fatty acids (SUM) when the native napin promoter (pMON72614) was driving expression of the KAS I and KAS IV genes was on average 4.96%. The combined levels of 16:0+18:0 fatty acids (SUM) when the long e-napin promoter (pMON72615) was driving expression of the KAS I and KAS IV genes was on average 4.52%. The combined levels of 16:0+18:0 fatty acids (SUM) when the short e-napin promoter (pMON72616) was driving expression of the KAS I and KAS IV genes was on average 4.68%. The long e-napin promoter thus gave a 8.8% decrease in the combined levels of 16:0+18:0 fatty acids over the native napin promoter, and the short e-napin promoter gave a 5.6% decrease in the combined levels of 16:0+18:0 fatty acids over the native napin promoter. Some multicopy-gene insertion events, arising from transformations with either pMON72614, pMON72615, or pMON72616 demonstrated a zero saturation phenotype. The zero saturate phenotype in these events was possibly due to the additive effects of having multiple copies of the KAS I and KAS IV coding sequence expressed in the seed, but a larger population plants could be screened to identify a single-copy, zero saturate phenotype event.

TABLE 3

Saturate levels in canola plants			
Construct and Event	16:0 (%)	18:0 (%)	SUM (%)
<u>pMON72614 (napin promoter)</u>			
BN_G9304	2.69	1.83	4.52
BN_G9221	2.9	1.9	4.8
BN_G9483	3.19	1.63	4.82
BN_G9299	2.8	2.87	5.67
BN_G9466	3.63	1.39	5.02
<u>pMON72615 (long e-napin promoter)</u>			
BN_G10337	2.99	1.21	4.2
BN_G9343	2.8	1.22	4.02
BN_G9394	3.47	1.16	4.63
BN_G9386	3.15	1.51	4.66
BN_G9762	3.41	1.38	4.79
BN_G10769	3.48	1.38	4.86
<u>pMON72616 (short e-napin promoter)</u>			
BN_G9588	3.62	0.94	4.56
BN_G9593	3.55	1.09	4.64
BN_G9396	3.35	1.3	4.65
BN_G11616	3.12	1.61	4.73
BN_G1162	3.24	1.51	4.75
BN_G9595	3.56	1.23	4.79
<u>Non-transgenic control</u>			
SP30052:0808	4.37	1.63	6
SP30052:0809	4.49	1.55	6.04
SP30052:0810	5.65	1.87	7.52

Having illustrated and described the principles of the present invention, it should be apparent to persons skilled in the art that the invention can be modified in arrangement and detail without departing from such principles. We claim all



modifications that are within the spirit and scope of the claims. All publications and published patent documents cited herein are hereby incorporated by reference to the same

extent as if each individual publication or patent application is specifically and individually indicated to be incorporated by reference.

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SEQUENCE LISTING

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<213> ORGANISM: Artificial sequence

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<223> OTHER INFORMATION: Chimeric promoter sequence using enhancer from *Brassica rapa*

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&lt;213&gt; ORGANISM: Artificial Sequence

&lt;220&gt; FEATURE:

&lt;223&gt; OTHER INFORMATION: Chimeric promoter sequence using enhancer from Brassica rapa

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&lt;223&gt; OTHER INFORMATION: Chimeric promoter sequence using enhancer from Brassica rapa

&lt;400&gt; SEQUENCE: 4

ctgatacaca cttaagcatc atgtggaaag ccaaagacaa ttggagcgag actcagggtc	60
gtcataatac caatcaaaga cgtaaaacca gacgcaacct ctttggttga atgtaatgaa	120
agggatgtgt cttggtatgt atgtacgaat aacaaaagag aagatggaat tagtagtaga	180
aatatttggg agctttttta gcccttcaag tgtgcttttt atcttattga tatcatccat	240
ttgcgttggt taatgcgtct ctagatatgt tcttatatct ttctcagtg ctgataagtg	300
aaatgtgaga aaaccatacc aaacaaaat attcaaatct tatttttaaat aatgttgaat	360
cactcggagt tgccaccttc tgtgccaatt gtgctgaatc tatcacacta gaaaaaaca	420
tttcttcaag gtaatgactt gtggactatg ttctgaatc tcattaagtt tttattttct	480
gaagttaag tttttacott ctgttttgaa atatatcgtt cataagatgt cagccagga	540

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catgagctac acatcgacaca tagcatgcag atcaggacga tttgtcactc acttcaaaca	600
cctaagagct tctctctcac agcgcacaca catatgcatg caatatttac acgtgatcgc	660
catgcaaadc tccattctca cctttttatt ttctgaagtt taagttttta ccttctgttt	720
tgaatatata cgttcataag atgtcacgcc aggacatgag ctacacatcg cacatagcat	780
gcagatcagg acgatttgtc actcacttca aacacctaag agcttctctc tcacagcgca	840
cacacatatg catgcaatat ttacacgtga tcgccatgca aatctccatt ctacactata	900
aattagagcc tcggcttcac tctttactca aacaaaaact catcactaca gaacatacac	960
aagataattc	970

<210> SEQ ID NO 5  
 <211> LENGTH: 41  
 <212> TYPE: DNA  
 <213> ORGANISM: Artificial Sequence  
 <220> FEATURE:  
 <223> OTHER INFORMATION: Chimeric promoter sequence using enhancer from  
 Brassica rapa

<400> SEQUENCE: 5

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<210> SEQ ID NO 6  
 <211> LENGTH: 756  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 6

ctgatacaca cttaagcatc atgtggaaag ccaaagacaa ttggagcgag actcagggtc	60
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agggatgtgt cttggtatgt atgtacgaat aacaaaagag aagatggaat tagtagtaga	180
aatatttggg agctttttta gcccttcaag tgtgcttttt atcttattga tatcatccat	240
ttgcgttgtt taatgcgtct ctgatatatgt tcctatatct ttctcagtgt ctgataagtg	300
aaatgtgaga aaaccatacc aaacaaaat attcaaactc tatttttaat aatgttgaat	360
cactcggagt tgccacctc tgtgccatt gtgtgaatc tatcacacta gaaaaaaca	420
tttcttcaag gtaatgactt gtggactatg ttctgaatc tcattaagtt tttattttct	480
gaagttaaag tttttacott ctgttttgaa atatatcgtt cataagatgt cagccagga	540
catgagctac acatcgacaca tagcatgcag atcaggacga tttgtcactc acttcaaaca	600
cctaagagct tctctctcac agcgcacaca catatgcatg caatatttac acgtgatcgc	660
catgcaaadc tccattctca cctataaatt agagcctcgg cttcactctt tactcaaacc	720
aaaactcatc actacagaac atacacaaga taattc	756

<210> SEQ ID NO 7  
 <211> LENGTH: 715  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 7

ctgatacaca cttaagcatc atgtggaaag ccaaagacaa ttggagcgag actcagggtc	60
gtcataatac caatcaaaga cgtaaaacca gacgcaacct ctttggttga atgtaatgaa	120
agggatgtgt cttggtatgt atgtacgaat aacaaaagag aagatggaat tagtagtaga	180
aatatttggg agctttttta gcccttcaag tgtgcttttt atcttattga tatcatccat	240

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ttgcgttggt taatgcgtct ctagatatgt tectatatct ttctcagtg ctgataagt	300
aaatgtgaga aaaccatacc aaaccaaatt attcaaatct tatttttaaat aatgttgaat	360
cactcggagt tgccaccttc tgtgccaaatt gtgctgaatc tatcacacta gaaaaaaca	420
ttttttcaag gtaatgaatt gtggactatg ttctgaattc tcattaagtt tttattttct	480
gaagtttaag tttttacott ctgttttgaa atatatcgtt cataagatgt cacgccagga	540
catgagctac acatcgcaca tagcatgcag atcaggacga tttgtcactc acttcaaaca	600
cctaagagct tctctctcac agcgcacaca catatgcag caatatttac acgtgatcgc	660
catgcaaac tccattctca cctataaatt agagcctcgg cttcactctt tactc	715

<210> SEQ ID NO 8  
 <211> LENGTH: 1137  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica juncea

<400> SEQUENCE: 8

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cattttaaat ttcactattg gctgaatgct tcttctttga ggagaaaaca attcagatgg	180
cagaaatgta tcaaccaatg catatataca aatgtacctc ttgttctcaa aacatctatc	240
ggatgggttc atttgctttg tcattccaatt agtgactact ttatattatt cactcctctt	300
tattactatt ttcatgcgag gttgccatgt acattatatt tgtaaggatt gacgctattg	360
agcgtttttc ttcaattttc tttatttaag acatgggtat gaaatgtgtg ttagagttgg	420
gttgaatgag atatacgttc aagtgaagtg gcataccgtt ctcgagtaag gatgacctac	480
ctattcttga gacaaatgtt acatttttagt atcagagtaa aatgtgtacc tataactcaa	540
attcgattga catgtatcca ttcaacataa aattaaacca gcctgcactc gcattccat	600
ttcaagatat ttttcaaacc gttcggtccc tatccaccgg gtgtaacaag acggattccg	660
aatttgaggg attttgactc aaattcccaa tttatattga ccgtgactaa atcaacttta	720
acttctataa ttctgattaa gctcccaatt tatattccca acggcactac ctccaaaatt	780
tatatagact ctcattccct tttaaaccaa cttagtaaac gttttttttt ttaattttat	840
gaagttaagt ttttaccctg tttttaaaaa gaatcggtca taagatgcca tgccagaaca	900
ttagctacac gttacacata gcattgcagc gcggagaatt gtttttcttc gccacttgtc	960
actcccttca aacacctaag agcttctctc tcacacgaca cacatacaat cacatgcgtg	1020
catgcattat tacacgtgat cgccatgcaa atctccttta tagcctataa attaactcat	1080
ccgcttcact ctttactcaa accaaaactc atcaatacaa acaagattaa aaacata	1137

<210> SEQ ID NO 9  
 <211> LENGTH: 1147  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 9

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tttccaacat tttaaatttc actattggct gaatgcttct tctttgagga agaaacaatt	180
cagatggcag aaatgtatca accaatgcat atatacaaat gtacctcttg ttctcaaaac	240

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atctatcgga tggttccatt tgccttgca tccaattagt gactacttta tattattcac	300
tcctctttat tactattttc atgcgagggt gccatgtaca ttatatttgt aaggattgac	360
gctattgagc gtttttcttc aattttcttt atttttagaca tgggtatgaa atgtgtgtta	420
gagttgggtt gaatgagata tacgttcaag cgaatggcat accgttctcg agtaaggatg	480
acctacccat tcttgagaca aatgttacat tttagtatca gagtaaaatg tgtacctata	540
actcaaatc gattgacatg tatccattca acataaaatt aaaccagcct gcacctgcat	600
ccacatttca agtattttca aaccgttcgg ctccctatcca ccgggtgtaa caagacggat	660
tccgaatttg gaagattttg actcaaatc ccaatttata ttgacctga ctaaatcaac	720
tttaacttct ataattctga ttaagctccc aatttatatt cccaacggca ctacctcaa	780
aatttataga ctctcatccc cttttaaac aacttagtaa acgttttttt tttaatttt	840
atgaagttaa gtttttacct tgtttttaa aagaatcgtt cataagatgc caccgacaa	900
cattagctac atgttacaca tagcatgcag ccgaggagaa ttgttttct tcgccacttg	960
tcactccctt caaacaccta agagcttctc tctcacagca cacacatata atcacatgcg	1020
tgcattgcatt attacacgtg atcgccatgc aaatctcctt tatagcctat aaattaactc	1080
atccgcttca ctctttactc aaacaaaaac tcatcaatac aaacaagatt aaaaacatac	1140
aggatcc	1147

&lt;210&gt; SEQ ID NO 10

&lt;211&gt; LENGTH: 3289

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Brassica napus

&lt;400&gt; SEQUENCE: 10

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ggcaagtatt cagttaccag ttaccactta tattctggac tttctgactg catcctcatt	120
tttccaacat tttaaatttc actattggct gaatgcttct tctttgagga agaaacaatt	180
cagatggcag aaatgtatca accaatgcat atatacaaat gtacctcttg ttctcaaaac	240
atctatcgga tggttccatt tgccttgca tccaattagt gactacttta tattattcac	300
tcctctttat tactattttc atgcgagggt gccatgtaca ttatatttgt aaggattgac	360
gctattgagc gtttttcttc aattttcttt atttttagaca tgggtatgaa atgtgtgtta	420
gagttgggtt gaatgagata tacgttcaag tgaagtggca taccgttctc gagtaaggat	480
gacctacca ttcttgagac aaatgttaca ttttagtata agagtaaaat gtgtacctat	540
aactcaaat cgattgacat gtatccattc aacataaaat taaaccagcc tgcacctgca	600
tccacatttc aagtattttc aaaccgttcg gctcctatcc accgggtgta acaagacgga	660
ttccgaattt ggaagatttt gactcaaat cccaatttat attgacctg actaaatcaa	720
ctttaacttc tataattctg attaatctcc caatttatat tccaacggc actacctca	780
aaatttatag actctcatcc ccttttaaac caacttagta aacgtttttt tttaatttt	840
tatgaagtta agtttttacc ttgtttttaa aaagaatcgt tcataagatg ccattgccaga	900
acattagcta cactgtacac atagcatgca gccgcggaga attgttttct tcgccactt	960
gtcactccct tcaaacacct aagagcttct ctctcacagc acacacatac aatcacatgc	1020
gtgcattgcat tattacacgt gatcgccatg caaatctcct ttatagccta taaattaact	1080
catccgcttc actctttact caaacaaaa ctcatcaata caaacaagat taaaaacata	1140
cacgaatggc gaacaagctc ttctctgtct cggcaactct cgccttcttc ttcttctca	1200

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cttgccagca gtggctccac aagcaagcaa tgcagtctgg cggtggtcct agctggaccc 1380
tcgacgggtga gtttgacttt gaagacgaca tggagaaccc gcagggtcca cagcagagac 1440
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caaccttgaa aggagcatcc aaagcgggta aacaacaaat tcaacaacag ggacaacagc 1560
aaggaaagca gcaaatgggtg agccgtatct accagaccgc tacgcaacta cctaaagttt 1620
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tctttgttat ccacaagaaa taacacacat gcatgatcaa gaggaagaga catggaaaaa 2160
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ccattctcaa gaaattatat tctttctttt cgttagagct atatatagca gacaaatccc 2460
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ttttgttata aatggtaacc tttttggagc taccttatcc actatttggg atgaaatgaa 2700
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gctggttagg aatcgaataa ccagtttgag aatgttgat gctcgaaagt ataacaaggc 2820
catggaaact tggttctcct acagatgatt ctttgttttc tgtctctgtt ttcctttttt 2880
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tacctcccc ttcttacata ttagtctcct ttttacattc tagtaagaaa ccaaaattgc 3240
atcagttgct ccataccctt cacctcatcc attctcatca aagagatct 3289

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&lt;210&gt; SEQ ID NO 11

&lt;211&gt; LENGTH: 1257

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Brassica napus

&lt;400&gt; SEQUENCE: 11

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ctctcccaat ttatatccac aacggcacta cctccaaaat ttttagactc tegtccctt	180
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gagctccacc aggaagagcc cctttgcgtt tgcccaacct tgaaggagc atccaaagcg	900
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cccttcacga agaccatgcc tgggccctcc tactagatcc caaacgaaac cctcgagtgt	1080
atgaatgtgg ttgtcgatat atgtcaacac cacacctcat cgcgtgtttc ataataatat	1140
gtaagggttt atctaggatg tttgaggcta atgtaaaatt agcactactc cataataaaa	1200
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&lt;210&gt; SEQ ID NO 12

&lt;211&gt; LENGTH: 1993

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Brassica napus

&lt;400&gt; SEQUENCE: 12

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ggcaagtatt cagttaccac ttatatcttg gactttctga ctgcactctc atttttccaa	120
cattttaaat ttcactattg gctgaatgct tcttctttga ggaagaaaca attcagatgg	180
cagaaatgta tcaaccaatg catatataca aatgtacctc ttgttctcaa aacatctatc	240
ggatgggttc atttgctttg tcatccaatt agtgactact ttatattatt cactcctctt	300
tattactatt ttcatgcgag gttgcatgt acattatatt tgtaaggatt gacgctattg	360
agcgtttttc ttcaattttc tttatttttag acatgggtat gaaatgggtg ttagagttgg	420
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ttcgattgac atgtatccat tcaacataaa attaaaccag cctgcacctg catccacatt	600
tcaagtattt tcaaacggtt cggctcctat ccaccgggtg taacaagacg gattccgaat	660
ttggaagatt ttgactcaaa ttcccaattt atattgaccg tgactaaatc aactttaact	720
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agactctcat ccccttttaa accaacttag taaacgtttt tttttttaat tttatgaagt	840
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tcactcttta	ctcaaaccaa	aactcatcaa	tacaacaag	attaaaaaca	tacacgaatg	1140
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aaaggagcat	ccaaagcggg	taaacaacaa	attcaacaac	agggacaaca	gcaaggaaag	1560
cagcaaatgg	tgagccgtat	ctaccagacc	cgtacgaact	tacctaaagt	ttgcaacatc	1620
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aacgaaacct	tcgagtgtat	gaatgtggtt	gtcgatatat	gtcaacacca	cacctcatcg	1740
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cactactcca	taataaaaga	gaggtcttta	atgtttaatt	tactcgatca	atcatcttag	1860
ttaactcgta	catgggcttt	taacggcaag	cgaaacaccg	ttcaaactgc	tctgtgactg	1920
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tagagaaaca	act					1993

<210> SEQ ID NO 13  
 <211> LENGTH: 1137  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica oleracea

<400> SEQUENCE: 13

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aaatttcact	attggctgaa	tgcttcttct	tctttgagga	agaaacagtt	cagatggcag	180
aaatgtatca	accaatgcat	atatacaaat	gtacctcttg	ttcttaaaac	atctatcgga	240
tggttccatt	tgctttgtca	tccaattagg	tgactacttt	atattattca	ctcctcttta	300
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gttgatgag	attcccgta	aagtgaattg	gcataccgtc	cccgggtaag	ggtgaccccc	480
catcctgggg	aaaatgttac	attttagggg	actcagggga	atggggctcc	attactcaaa	540
tccgggggaa	atgtttccct	tcaacataaa	attaaaccgg	gccggacccg	aatccccaat	600
tcaagggttt	taaccggcct	tccgggagcc	cccaaccgga	ccggggtcct	atccagcggt	660
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ccgtataatt	ctgggttaagc	tgccaaatta	tatccgaacg	gcactacctc	caaaatttaa	780
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aagttgagtt	ttaccttgt	tttgaaggg	agtcgttcat	gagatgccat	gccagaacat	900
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catgcattat tacacgtgat cgccatgcaa atctccctta tgcctataa attaactcat	1080
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<210> SEQ ID NO 14  
 <211> LENGTH: 1026  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 14

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cgatttgtea ctcacttcaa acacctaaaa gagcttctct ctcacagcac acacacatat	180
gcatgcaata tttacacgtg atcgccatgc aaatctccat tctcacctat aaattagagg	240
ctcggcttca cttttttact caaaccaaaa ctcacacta caaacatac acaaatggcg	300
aacaagctct tcctcgtctc ggcaactctc gccttggtct tccttctcac caatgcctcc	360
gtctacagga cgggttggtga agtcgacgaa gacgatgcca caaatccagc cggcccattt	420
aggattccaa aatgtagaaa ggagtttcag caagcacaac acctaagagc ttgccacaa	480
tggctccaca agcaggcaat gcagcccggt ggtggtagt gtccaagctg gactctcgac	540
ggtgagtgtt attttgaaga cgacgtggag aaccaacaac agggcccaca gcagaggcca	600
cgcgcacccc agcagtgtg caacgagctc caccaggaag agccactttg cgtttgccca	660
accttgaaag gagcatccaa agccgttaga caacagggtc gacaacaaca gggacaacaa	720
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cctagagttt gcaacatcag gcaagttagc atttgtccct tccagaagac catgcctggg	840
cccggcttct actagattcc aaacgaaata tcctcgagag tgtgtatacc acggtgatat	900
gagtgtgggt gttgatgtat gttaacacta catagtcatg gtgtgtgttc cataaataat	960
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<210> SEQ ID NO 15  
 <211> LENGTH: 2084  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 15

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aacttggtga taaatattct ctgaaagtga cttcttttag gcatatgtag gttgcatgac	180
aaaactgagg aagattaacc ttctcaattt aagggaagg aggaacagcc gaagaagaaa	240
taagaatagt cagtctgeat ctcatgactc agcttaacgg tcgtcgtcct catgaacaga	300
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aactggattc acttctcaag tttatgagtt gtcaccggtc ttctacaca aggtaataat	540
cagttgaagc aattaagaat caatttgatt ttagtagaac taagaagaac ttaccttatg	600
ttttccccgc aggactggat tatggaacaa tgggaaaaga actactatat aagctccata	660

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gaactactta ttctcagcag tcatacaaaag tgagtgactc atttcggtc aagtggataa	840
ataagaaatg gaaagaagat tttcatgtaa cctccatgac aactgctggg aatcgttggg	900
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&lt;210&gt; SEQ ID NO 16

&lt;211&gt; LENGTH: 4329

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Brassica rapa

&lt;400&gt; SEQUENCE: 16

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ctaaaggttg ctggctgttt tcttggtcat atgattaact tctaaacttg tgtataaata	180
ttctctgaaa gtgcttcttt tggcatatgt aggttgggca aaaacgagga agattgcttc	240
tcaatttgga agaggatgaa cagccgaaga agaaaaaag aataggcagt cctgctactc	300
aatggatctc agtctataac ggtcgtcgtc ccatgaaaca gaggtaaaac attttttgca	360
tatacacttt gaaagtctct cactaactgt gtaatctttt ggtagatata actacaatgt	420
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ctgtgtagca tcagcageta atctctgggc tctcatcatg gatgctggaa ctggattcac	540
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&lt;210&gt; SEQ ID NO 17

&lt;211&gt; LENGTH: 4274

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Arabidopsis thaliana

&lt;400&gt; SEQUENCE: 17

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acgaaacaga gctttgtttt ggttacgatg cgggtgattt tgggtcgggt tagagtgata	180
tatatttggg accaaattta accaagattc gttttcggtt aaaacaaaat ttgattttta	240
agcatttttg gaaaaattag tgttatatat atgagatttc ttaatcaaaa tctcactttt	300
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<210> SEQ ID NO 18
<211> LENGTH: 1238
<212> TYPE: DNA
<213> ORGANISM: Arabidopsis thaliana

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<400> SEQUENCE: 18

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gtttgaggat tctctcgcct tctgtcgatc tctcgtggtt atttttgttt ttttcagtga 960

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agtgaagttg tttagttcga aatgacttcg tgtatgctcg attgatctgg ttttaattctt	1020
cgatctgtta ggtgttgatg tttacaagtg aattctagtg tttctcgtt gagatctgtg	1080
aagtttgaac ctagtcttct caataatcaa catatgaagc gatgtttgag tttcaataaa	1140
cgctgctaatt cttcgaaact aagttgtgat ctgattcgtg tttacttcat gagettatcc	1200
aattcatttc ggtttcattt tacttttttt ttagtgaa	1238

<210> SEQ ID NO 19  
 <211> LENGTH: 110  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 19

aggacgattt gtcactcact tcaaacacct aagagcttct ctctcacagc gcacacacat	60
atgcatgcaa tatttacacg tgatcgccat gcaaattctcc attctcacct	110

<210> SEQ ID NO 20  
 <211> LENGTH: 120  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica juncea

<400> SEQUENCE: 20

ttcgccactt gtcactccct tcaaacacct aagagcttct ctctcacagc acacacatac	60
aatcacatgc gtgcatgcat tatttacacg gatcgccatg caaatctcct ttatagccta	120

<210> SEQ ID NO 21  
 <211> LENGTH: 105  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 21

agaagaccat gcctgggccc tcctactaga ttccaaacga aaccctcgag tgtatgaatg	60
tggttgctga tatatgtcaa caccacacct catcgcggtg ttcac	105

<210> SEQ ID NO 22  
 <211> LENGTH: 119  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 22

tcgccacttg tcaactccctt caaacaccta agagcttctc tctcacagca cacacatata	60
atcacatgcg tgcattgcatt attacacgtg atcgccatgc aaatctcctt tatagccta	119

<210> SEQ ID NO 23  
 <211> LENGTH: 119  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica oleracea

<400> SEQUENCE: 23

tcgccacttg tcctccctt caaacaccta agagcttctt taaaacagcc cacacagcca	60
atcacatgcg tgcattgcatt attacacgtg atcgccatgc aaatctcctt tatagccta	119

<210> SEQ ID NO 24  
 <211> LENGTH: 129  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 24

agaagaccat gcctgggccc ggcttctact agattccaaa cgaaatatcc tcgagagtgt	60
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gtataccacg gtgatatgag tgtggttggt gatgtatggt aacactacat agtcatgggtg 120  
 tgtgttcca 129

<210> SEQ ID NO 25  
 <211> LENGTH: 108  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 25

aggacgattt gtcactcact tcaaacacct aagagcttct ctctcacagc gcacacacat 60  
 atgcatgcaa tattacacgt gatgcatgca aatctccatt cttcacct 108

<210> SEQ ID NO 26  
 <211> LENGTH: 115  
 <212> TYPE: DNA  
 <213> ORGANISM: Arabidopsis thaliana

<400> SEQUENCE: 26

agaccaccat ccttttcttc cctccttact aatagattcc aaacaaaaac cctcgagcgt 60  
 atgagagtgt ggttggtgat acatgttaac accacacctc atcgtgtctt ttatg 115

<210> SEQ ID NO 27  
 <211> LENGTH: 104  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica rapa

<400> SEQUENCE: 27

ttttattttc tgaagttaa gtttttacct tctgttttga aatatatcgt tcataagatg 60  
 tcacgccagg acatgagcta cacatcgcac atagcatgca gatc 104

<210> SEQ ID NO 28  
 <211> LENGTH: 120  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica juncea

<400> SEQUENCE: 28

tttttaattt tatgaagtta agtttttacc ttgtttttta aaagaatcgt tcataagatg 60  
 ccatgccaga acattagcta cactgttacac atagcatgca gccgcgagaga attgtttttc 120

<210> SEQ ID NO 29  
 <211> LENGTH: 120  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 29

tttttaattt tatgaagtta agtttttacc ttgtttttta aaagaatcgt tcataagatg 60  
 ccacgccaga acattagcta catgtttacac atagcatgca gccgcgagaga attgtttttc 120

<210> SEQ ID NO 30  
 <211> LENGTH: 120  
 <212> TYPE: DNA  
 <213> ORGANISM: Brassica napus

<400> SEQUENCE: 30

ttggttaattt tatgaagtta agtttttacc ttgtttttta aaagaatcgt tcataagatg 60  
 ccatgccaga acattagcta cactgttacac atagcatgca gccgcgagaga attgtttttc 120

<210> SEQ ID NO 31



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<211> LENGTH: 120
<212> TYPE: DNA
<213> ORGANISM: Brassica napus

<400> SEQUENCE: 31
caacaaattc agcaacaggg acaacagcaa ggaaagctgc aaatggtgag ccgtatctac      60
cagacagcta ctcaacttacc taaagtttgc aaaatcccgc aagtttagcgt atgtcccttc      120

<210> SEQ ID NO 32
<211> LENGTH: 121
<212> TYPE: DNA
<213> ORGANISM: Brassica oleracea

<400> SEQUENCE: 32
ttggtaatTT tttgaagttg agtttttacc ttgttttgga agggagtcgt tcatgagatg      60
ccatgccaga acattagcta gccggttaca catagcatgc agccgaggag gattgttttt      120
c                                                                121

<210> SEQ ID NO 33
<211> LENGTH: 133
<212> TYPE: DNA
<213> ORGANISM: Brassica napus

<400> SEQUENCE: 33
caacaggttc gacaacaaca gggacaacaa atgcagggac agcagatgca gcaagtaatt      60
agccgtgtct accagactgc tacgcactta cctagagttt gcaacatcag gcaagtttagc      120
attgtccct tcc                                                                133

<210> SEQ ID NO 34
<211> LENGTH: 129
<212> TYPE: DNA
<213> ORGANISM: Brassica rapa

<400> SEQUENCE: 34
ttttattttc gegaagttaa gtttttacct tctgttttga aatatatcgt tcataacatc      60
gttctcacgc caggaccatt gcagctacat accattgcag catctaccat tcgccatgca      120
atgcagatc                                                                129

<210> SEQ ID NO 35
<211> LENGTH: 103
<212> TYPE: DNA
<213> ORGANISM: Arabidopsis thaliana

<400> SEQUENCE: 35
ctccagggac aacacggacc attccaatcc aggaaaattt acaagacagc taagtacttg      60
cctaacattt gcaagatcca gcaagttggt gaatgccct tcc                                                                103

<210> SEQ ID NO 36
<211> LENGTH: 1348
<212> TYPE: DNA
<213> ORGANISM: Artificial Sequence
<220> FEATURE:
<223> OTHER INFORMATION: Chimeric promoter sequence using enhancer from
      Brassica rapa

<400> SEQUENCE: 36
actagtcaac aattggccaa tctttgttct aaattgctaa taaacgacca ttccgctcaa      60
ttctccttgg ttgcaacagt ctaccgtca aatgtttact aatttataag tgtgaagttt      120

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gaattatgaa agacgaaatc gtattaaaaa ttcacaagaa taaacaactc catagatttt	180
caaaaaaaca gtcacgagaa aaaaccaca gtccgtttgt ctgctcttct agttttttatt	240
atttttctat taatagtttt ttgttatttc gagaataaaa tttgaacgat gtccgaacca	300
caaaagccga gccgataaat cctaagccga gcctaacttt agccgtaacc atcagtcacg	360
gtcccgggc taattcattt gaaccgaatc ataatcaacg gtttagatca aactcaaac	420
aatctaacgg caacatagac gcgtcgggtga gctaaaaaga gtgtgaaagc caggtcacca	480
tagcattgtc tctcccagat tttttatttg ggaaataata gaagaaatag aaaaaataa	540
aagagtgaga aaaatcgtag agctatatat tcgcacatgt actcgtttcg ctttccttag	600
aggacgattt gtcactcact tcaaacacct aagagcttct ctctcacage gcacacacat	660
atgcatgcaa tatttacacg tgatcgccat gcaaatctcc attctcacct tgtagctgc	720
tgccgctgtt gtttctctc catttctcta tctttctctc tcgctgcttc tcgaatcttc	780
tgtatcatct tcttctctct caagggtgagt ctctagatcc gttcgttga ttttgcgtct	840
cgttagtcgt tattgttgat tctctatgcc gatttcgcta gatctgttta gcatgcgttg	900
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gttgatcgta tctgagctaa ttcttaaggt ttatgtgtta gatctatgga gtttgaggat	1020
tcttctcgtc tctgtcgatc tctcgctgtt atttttgttt ttttcagtga agtgaagttg	1080
tttagttcga aatgacttcg tgtatgctcg attgatctgg ttttaatctt cgatctgtta	1140
gggtgtgatg tttaacaagt aattctagt ttttctcgtt gagatctgtg aagtttgaac	1200
ctagttttct caataatcaa catatgaagc gatgtttgag tttcaataaa cgctgcta	1260
cttcgaaact aagttgtgat ctgattcgtg ttacttcat gagcttatcc aattcatttc	1320
ggtttcattt tacttttttt ttagtga	1348

&lt;210&gt; SEQ ID NO 37

&lt;211&gt; LENGTH: 1342

&lt;212&gt; TYPE: DNA

&lt;213&gt; ORGANISM: Artificial Sequence

&lt;220&gt; FEATURE:

&lt;223&gt; OTHER INFORMATION: Chimeric promoter sequence using enhancer from Brassica rapa

&lt;400&gt; SEQUENCE: 37

actagtcaac aattggccaa tctttgttct aaattgctaa taaacgacca ttccgtcaa	60
ttctccttgg ttgcaacagt ctaccgtca aatgtttact aatttataag tgtgaagttt	120
gaattatgaa agacgaaatc gtattaaaaa ttcacaagaa taaacaactc catagatttt	180
caaaaaaaca gtcacgagaa aaaaccaca gtccgtttgt ctgctcttct agttttttatt	240
atttttctat taatagtttt ttgttatttc gagaataaaa tttgaacgat gtccgaacca	300
caaaagccga gccgataaat cctaagccga gcctaacttt agccgtaacc atcagtcacg	360
gtcccgggc taattcattt gaaccgaatc ataatcaacg gtttagatca aactcaaac	420
aatctaacgg caacatagac gcgtcgggtga gctaaaaaga gtgtgaaagc caggtcacca	480
tagcattgtc tctcccagat tttttatttg ggaaataata gaagaaatag aaaaaataa	540
aagagtgaga aaaatcgtag agctatatat tcgcacatgt actcgtttcg ctttccttag	600
ttttattttc tgaagtttaa gtttttacct tctgttttga aatatatcgt tcataagatg	660
tcacgccagg acatgagcta cacatcgac atagcatgca gatctgttag ctgctgccgc	720
tgttgtttct cctccatttc tctatcttct tctctcgtg cttctcgaat cttctgtatc	780

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atcttcttct tcttcaaggt gactctctag atccgttcgc ttgattttgc tgctcgtag	840
tcgttattgt tgattctcta tgcgatttc gctagatctg tttagcatgc gttgtggttt	900
tatgagaaaa tctttgtttt gggggttgct tgttatgtga ttcgatccgt gcttggttga	960
tcgatctgag ctaattctta aggtttatgt gttagatcta tggagtttga ggattcttct	1020
cgcttctgtc gatctctcgc tgttattttt gtttttttca gtgaagtga gttgtttagt	1080
tcgaaatgac ttcgtgtatg ctcgattgat ctggttttta tcttcgatct gttaggtgtt	1140
gatgtttaca agtgaattct agtgttttct cgttgagatc tgtgaagttt gaacctagtt	1200
ttctcaataa tcaacatatg aagcgatgtt tgagtttcaa taaacgctgc taatcttcga	1260
aactaagttg tgatctgatt cgtgtttact tcatgagctt atccaattca tttcggtttc	1320
attttacttt ttttttagtg aa	1342

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The invention claimed is:

1. A chimeric promoter comprising a first DNA molecule combined with a second DNA molecule, wherein said first DNA molecule is a native napin promoter comprising a sequence selected from the group consisting of SEQ ID NOs: 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 and said second DNA molecule comprises SEQ ID NO:19, wherein said first DNA molecule and said second DNA molecule are a heterologous combination, and wherein the chimeric promoter has increased seed expression compared to said native napin promoter.

2. A chimeric promoter comprising a first DNA molecule and a second DNA molecule, wherein said first DNA molecule is a native napin promoter and said second DNA molecule comprises SEQ ID NO:19, wherein said first DNA molecule and said second DNA molecule are a heterologous combination, wherein the chimeric promoter has increased seed expression compared to the native napin promoter, and wherein said chimeric promoter has gene regulatory activity and a DNA sequence with at least 97 percent identity to SEQ ID NO:1.

3. The chimeric promoter of claim 2, wherein said chimeric promoter has gene regulatory activity and a DNA sequence with at least 99 percent identity SEQ ID NO:1.

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4. The chimeric promoter of claim 2, wherein said chimeric promoter comprises the DNA sequence of SEQ ID NO:1.

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5. A DNA construct comprising the chimeric promoter of claim 1, and wherein said chimeric promoter is operably linked to a heterologous transcribable polynucleotide molecule.

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6. The DNA construct of claim 5, wherein said chimeric promoter comprises the DNA sequence of SEQ ID NO: 1.

7. The DNA construct of claim 5, wherein the transcribable polynucleotide molecule is a gene of agronomic interest.

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8. The DNA construct of claim 7, wherein the gene of agronomic interest is capable of providing a modified oil composition.

9. A transgenic plant cell comprising the DNA construct of claim 5.

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10. The transgenic plant cell of claim 9, wherein said transgenic plant cell is a dicotyledonous plant cell.

11. The transgenic plant cell of claim 10, wherein said transgenic plant cell is selected from the group consisting of tobacco plant cell, tomato plant cell, potato plant cell, soybean plant cell, cotton plant cell, canola plant cell, sunflower plant cell and alfalfa plant cell.

12. A transgenic plant comprising the chimeric promoter of claim 1.

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